CHAPTER 3 – SECTION 501
(Asphaltic Concrete Mixtures)

This chapter describes the required procedures and necessary documentation for designing an asphaltic concrete mixture for use on a DOTD project under Section 501 of the *Standard Specifications* (Marshall mix design system). It also details the responsibilities of the Certified Asphaltic Concrete Plant Technician (Quality Control), the DOTD Certified Asphaltic Concrete Plant Inspector and the district laboratory. In addition, several other items are discussed pertaining to definition of lot size, small quantities, JMF resubmittals (rewrites).

MIX DESIGN STEPS AND APPROVAL

Listed below are the general steps required to design, approve and validate an asphaltic mixture according to the Marshall method (Section 501).

- Material procurement and approval (fine aggregate, coarse aggregate, asphalt cement, anti-strip and other additives)
- Gradation and Bulk Specific Gravity (G_{sb}) determination of aggregates
- Blending of aggregates to meet specified gradation
- Trial blends with varying asphalt cement contents
- Selection of optimum asphalt cement content
- Moisture sensitivity analysis
- Submittal process and Documentation – (JMF Release Form)
- Approval of JMF Release Submittal
- Validation of JMF Release Submittal
- Final Approval of JMF

1 - Material Procurement and Approval

All samples are to be obtained in accordance with the requirements of the *Materials Sampling Manual*. A DOTD Sample Identification form (or an Aggregate Test Report form) must be completed for each material to be used (Appendix M and N). Samples should be submitted at least three weeks prior to the submission of the job mix proposal (JMF). JMF submittals require 7 days for approval. No proposed JMF will be approved until all mix components have been sampled and approved.

Coarse Aggregate - Coarse aggregates approved for use in hot-mix asphalt are listed in QPL 2. This compilation lists all approved aggregates for use on DOTD projects along with their specific allowable use (hot-mix, concrete, etc.), friction rating, water absorption, Bulk SSD Specific Gravity ($G_{sb}SSD$) and Source Code.

Coarse aggregate shall comply with Table 501-2 Aggregate Friction Rating. This table specifies allowable usage according to mixture type. The mixture type will be shown on the pavement cross-sections in the contract plans. (Table 1003-3 shows the friction rating delineation ranges for each type.) RAP aggregate will be assigned a friction rating of III. Subsection 501.02(c) lists the minimum amount of crushed coarse aggregates required in each mixture type.

Reclaimed Asphalt Pavement (RAP) - According to Subsection 1003.01(a)(4), Recycled Asphalt Pavement (RAP), if used along with virgin material, shall be cold planed and crushed. Stockpiled RAP materials shall be uniform and reasonably free of lightweight aggregate, debris, soil and other foreign matter. The proposed RAP material will be approved for use by the district laboratory engineer prior to use.

RAP for use in hot-mix asphalt is not required to be from sources listed on QPL 2, but shall be from approved sources. A sample of these materials (taken from the stockpile) shall be submitted to the district laboratory for this approval. Section 501 of the *Materials Sampling Manual* and the Project Sampling Plan outline the minimum quantity required.

Fine Aggregate - Fine aggregates for use in hot-mix asphalt shall be approved for use by the district laboratory. DOTD personnel shall obtain a sample of fine aggregate [natural sands as defined by Subsection 1003.06(a)(3)] from a stockpile and submit it to the district laboratory for initial approval and non-QPL source code assignment. Natural sands shall consist of clean, hard, durable, siliceous grains and shall be reasonably free from vegetative matter or other deleterious materials. The district laboratory will determine if the material has less than 25 percent maximum passing the No. 200 sieve in accordance with TR 112 and less than 1.00 percent by weight clay lumps when sampled from the stockpile and tested in accordance with TR 119. The *Materials Sampling Manual*, in Section 501, specifies the minimum sample quantity required. This initial source approval will require two to four weeks. The district laboratory, upon approval of the natural fine aggregate source, will provide a non-QPL Source Code for the material. These source codes are printed in the DOTD *MATT System Field Handbook*.

Asphalt Cement - Asphalt cement shall also be from an approved source listed in QPL 41. Asphalt cement grade is specified in Table 501-1 – Asphalt Cement Usage By Mixture Type. Currently, LA DOTD allows the use of four performance graded asphalt cements (PG 64-22, PG 70-22m, PG 76-22m and PG 58-28. The specification requirements for these materials are listed in Table 1002-1 of the *Standard Specifications*. Note that PG 76-22m asphalt cement may be substituted for PG 70-22m or PG 64-22 asphalt cements at no increase in price. In addition, PG 70-22m Alternate asphalt cement may be substituted for PG 70-22m at no increase in price. When 20 to 30 percent RAP is used, PG 58-28 is required. PG 58-28 may not be substituted for any other asphalt cement.

If a wearing course is substituted for a binder course, or if a binder course is substituted for a base, the grade of asphalt cement required will be in accordance with the original mixture type shown in the plans and as specified in Table 501-1.

DOTD accepts asphalt cement at the plant by a Certificate of Delivery (CD) (Appendix O). This Certificate of Delivery shall accompany each load delivered to the plant. Frequency of sampling and testing for each transport load of asphalt cement delivered to the plant is outlined in the *Materials Sampling Manual*.

Additives – Anti-strip shall be added to all mixtures at a minimum rate of 0.5 percent by weight of asphalt and be thoroughly mixed in-line with the asphalt cement at the plant. Anti-strip used shall be listed in QPL 57. Additional anti-strip may be added up to 1.2 percent by weight of asphalt cement. When tested in accordance with AASHTO T 283 with one freeze-thaw cycle, the rate listed on the proposed Job Mix Formula (JMF) shall be 0.1 percent greater than the percentage that will yield a minimum tensile strength ratio (TSR) of 75 percent for mixtures using PG 58-22 or PG 64-22 or a TSR of 80 percent for mixtures using PG 70-22m and PG 76-22m. Therefore, the minimum rate that can be listed on the proposed JMF is 0.6 percent. A Certificate of Delivery shall accompany each load of anti-strip delivered to the plant.

Silicone additives, when needed, shall be from those listed in QPL 22. They shall be dispersed into the asphalt cement by methods and in concentrations given in the QPL list. A Certificate of Delivery shall accompany each load of silicone additives.

Hydrated lime, if used, shall be from a source listed in QPL 34. The minimum rate shall not be less than 1.5 percent by weight of the total mixture. Further, hydrated lime shall be added to and thoroughly mixed with aggregates in accordance with Subsection 503.02(e). Hydrated lime may be also added as mineral filler. A Certificate of Delivery (Appendix P) shall accompany each load of hydrated lime.

Mineral filler, if used, shall be an approved product listed in QPL 10 and shall consist of limestone dust, pulverized hydrated lime (QPL 34), shell dust, Portland cement (QPL 7) or cement stack dust. Mineral dust collected in bag houses or by other dust collectors at asphalt plants is not classified as mineral filler. A Certificate of Delivery (Appendix P) shall accompany each load of mineral filler delivered to the plant.

2 – Aggregate Testing

Bulk Specific Gravity (G_{sb}) – Once proposed aggregate materials have been stockpiled at the plant and are approved for use (either listed in QPL 2 for coarse aggregate and coarse sand or listed in the Non-QPL Materials Code Section of the *Matt System Field Handbook* for other materials*),* the QC technician and the department inspector shall jointly determine the bulk specific gravity of each mineral aggregate material.

AASHTO Test Procedure T 84 shall be used to determine G_{sb} and absorption for each proposed fine aggregate source. Note that fine aggregate is defined in the *Standard Specifications* as all material passing the No. 4 sieve.

The QC technician shall use AASHTO Test Procedure T 85 to determine G_{sb} and absorption for each proposed coarse aggregate source. Note that coarse aggregate is defined in the *Standard Specifications* as all material retained on or above the No. 4 sieve. For coarse aggregates containing ten percent or less material by weight passing the No. 4 sieve, a G_{sb} determination on that passing portion will not be required.

However, should the proposed coarse aggregate stockpile contain more than ten percent passing the No. 4 sieve, then the finer portion shall be separated and tested in accordance with AASHTO T 84. The two results, for both coarse and fine portions, shall then be mathematically combined in proportion to the amounts retained on the No. 4 and passing the No. 4 to produce a single G_{sb} value for the source. The G_{sb} is used to calculate VMA and asphalt absorption. False high values for G_{sb} will lead to high VMA's and negative absorptions. If negative absorptions are reported, the G_{sb} shall be adjusted and the district laboratory engineer shall be notified.

When mathematically combining bulk specific gravities of two or more aggregates, use the following equation:

$$G_{sb} = \frac{1}{\frac{P_1}{100(G_1)} + \frac{P_2}{100(G_2)}}$$

where:

G_{sb} = Bulk specific gravity of the total aggregate
P_1 & P_2 = Percentages by weight of each aggregate size
G_1 & G_2 = Bulk specific gravity each aggregate size
100 = constant to convert percentage to decimal form.

The QC technician and department inspector shall jointly obtain two samples for G_{sb} determination from each proposed aggregate stockpile. The QC technician shall test one sample; the DOTD inspector will submit the other, along with a Sample Identification Form, to the district laboratory. The contractor may use the calculated values for bulk specific gravity and water absorption on the proposed JMF provided that they are within the range specified in the specific test procedure. Listed below are the acceptable ranges for bulk specific gravity and water absorption values determined from multi-laboratory precision analysis:

Multi-laboratory Precision for Bulk Specific Gravity (G_{sb})	
Material and Test Procedure	**G_{sb}**
Fine Aggregate – T 84 or TR 300	± 0.035
Coarse Aggregate – T 85 or TR 300	± 0.020

Should the contractor's values be outside this range when compared to the district laboratory, both parties shall jointly run a third test, the results of which shall be used for volumetric calculations on the proposed JMF submittal. Bulk specific gravity values agreed upon by this procedure shall be used on subsequent job mix formula submittals. However, the G_{sb} may be retested at either party's request. If G_{sb} results are within the tolerances for the test procedure, as compared to the previously determined values, the QC technician has the option of either using the new values or the previously agreed upon ones for which JMF's have already been approved and validated.

At the option of the contractor/producer or DOTD, if the proposed composite aggregate blend is already known, the bulk specific gravity may be performed on a "composite belt sample" separating the fine and coarse portions, in lieu of performing the G_{sb} procedure on each individual aggregate.

Gradation – The contractor/producer shall obtain a second sample from each proposed stockpile for gradation determination. An accurate gradation analysis is required for blending analysis and to determine consistency of incoming material.

It is recommended that the QC technician secure samples of all bulk shipments of aggregates delivered to the plant site. The gradation results of these shipments should be determined prior to addition to a working stockpile. Further, documentation of these continuous stockpile gradation and specific gravity results should be kept on file so that trends of the aggregate source may be determined.

Under Subsection 109.07 of the *Standard Specifications*, the department may allow advanced payment to a producer for stockpiled materials stored in excess of 90 calendar days for use on a DOTD project. When requested by the contractor/producer, a written detailed description of the material, its intended use, and location shall be provided to the project engineer. Refer to the section on dedicated stockpiles in this manual.

When inspecting and testing aggregates, a certified technician should, at all times, be cognizant of proper bulk material handling. Quality control of hot-mix asphalt, regardless of plant type, begins with proper stockpile management. Aggregates must be handled in a manner that will not be detrimental to the final mixture. Stockpiles shall be built in a manner that will not cause segregation. Segregation can be minimized if stockpiles are built in successive layers, not in a conical shape. Constructing stockpiles in layers enables different aggregate fractions to remain evenly mixed and reduces the tendency of large aggregates to roll to the outside and bottom of the pile. Stockpiles shall be located on a clean, stable, well-drained surface to ensure uniform moisture content throughout the stockpile. The area in which the stockpiles are located shall be large enough for the stockpiles to be separated, so that no intermixing of materials will occur. Stockpiles shall not become contaminated with deleterious materials such as clay balls, leaves, sticks or nonspecification aggregates. Care shall be exercised not to segregate or contaminate the materials when moving aggregates from stockpiles to cold bins. Aggregates are often moved from stockpile to cold bin with a front-end loader. The operator should proceed directly into the stockpile, load the bucket and move directly out. He should not scoop aggregate from only the outside edges of the stockpile.

3 – Aggregate Blending

Following bulk specific gravity determinations and gradation analysis, the technician must determine a master composite blend of the proposed aggregates. Again, the mixture type may be determined from the typical sections in the project plans. The specific gradation requirements for each mixture type are listed in Table 501-3 in the *Standard Specifications*. Table 501-3 lists a nominal maximum size aggregate, a specification gradation limit for each mixture type, and a tolerance (plus and minus) for the proposed JMF blend.

Section 501 specifies three different nominal maximum size mixtures (1/2 inch [12.5 mm], ¾ inch [19.0 mm], and 1.0 inch [25.0 mm]). The following definitions are used by DOTD to determine these sizes:

- **Nominal Maximum Size (NMS) – One sieve size larger than the first sieve to retain more than 10 percent by weight of the combined aggregate.**

- **Maximum Size (MS)– One sieve size larger than the nominal maximum size.**

Table 501-4 lists the gradation control points and informational restricted zone boundaries for each nominal maximum size mixture.

Subsection 501.02(c) specifies the maximum amount of natural sands, by weight, allowed in each mixture type. They are listed below:

Mixture Type	**Maximum Percent Sand**
7H, 8 and 8F	15 percent
3, 7M and Incidental Paving	25 percent
7L	45 percent

Notes:

1. Incidental paving includes joint repair, leveling, driveways, turnouts, crossovers, detour roads and other items as approved by the engineer.
2. Type 5 Base Course does not have a maximum natural sand requirement.

Once the technician has mathematically determined a composite blend that will meet the requirements of Section 501, he shall plot the composite gradation on the appropriate *Asphaltic Concrete Gradation – 0.45 Power Curve* for the corresponding nominal maximum aggregate size (Appendices T, U and V). The “0.45 power curve” chart uses a unique graphing technique to show the cumulative particle size distribution of an aggregate blend. The ordinate (vertical axis) of the chart is percent passing. The abscissa (horizontal axis) is an arithmetic scale of sieve sizes, raised to the 0.45 power. On these charts, the maximum density grading for a particular maximum size corresponds to a straight line drawn from the origin to the selected maximum aggregate size. It must be noted that this **maximum density line** is approximate, but can serve as a useful reference in proportioning aggregates.

These power curves also depict two other features, which are specified in Table 501-4. The **control points** function as specification limits through which the composite gradation must pass. The **restricted zone** occurs along the maximum density gradation. The restricted zone was originally introduced as a guide to ensure that mixtures would have sufficient voids in the mineral aggregate (VMA) to allow sufficient asphalt cement for adequate durability. Another purpose of the restricted zone was to restrict the amount of natural sand in the mixture. Aggregates with excessive amounts of natural sand produce tender HMA mixes. Some aggregate gradations that pass through the restricted zone provide mixes that perform very well in service. It is no longer specified that composite blends avoid this zone.

Further, LA DOTD allows for all mixtures produced under Section 501 to be either on the coarse or fine side of the 0.45 power curve, yet within the control points. A coarse side gradation refers to one that falls below the restricted zone. Conversely, a fine side blend is one that would be drawn above the restricted zone. Typical coarse and fine-sided blends are shown in Figure 3-1.

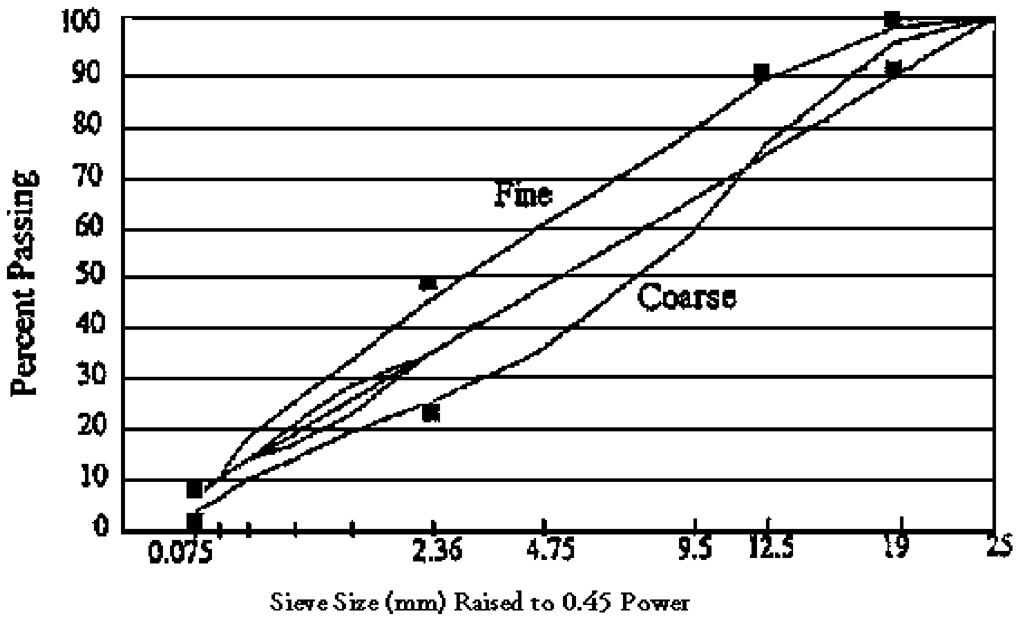

Figure 3-1 – 0.45 Power Curve with Coarse and Fine Sided Gradation

Care should be given in the selection of the final composite aggregate blend. Many coarse graded blends may, if not properly designed and compacted, lead to pavements that are very porous and allow water to permeate the base and subbase, causing premature failure.

The following is an example of the gradation requirements and a typical fine side proposed composite gradation for a Type 8 Wearing Course (3/4 inch [19.0 mm] NMS):

Sieve Size	Control Points	Restricted Zone	Mix Tolerance	Proposed JMF	JMF Limits
1.0 inch	100		± 6	100	100
¾ inch	90 – 100		± 6	94	90 – 100
½ inch	89 max		± 6	83	77 – 89
3/8 inch			± 6	73	
No. 04			± 6	54	
No. 08	23 – 49	35	± 5	42	37 – 47
No. 16		22 – 28	± 3	36	
No. 30		17 – 21	± 3	29	
No. 50		14	± 3	17	
No. 100			± 2.0	10	
No. 200	2.0 – 8.0		± 2.0	4.8	2.8 – 6.8

Figure 3-2 shows the proposed JMF gradation plotted on the 19.0 mm 0.45 power curve with control points.

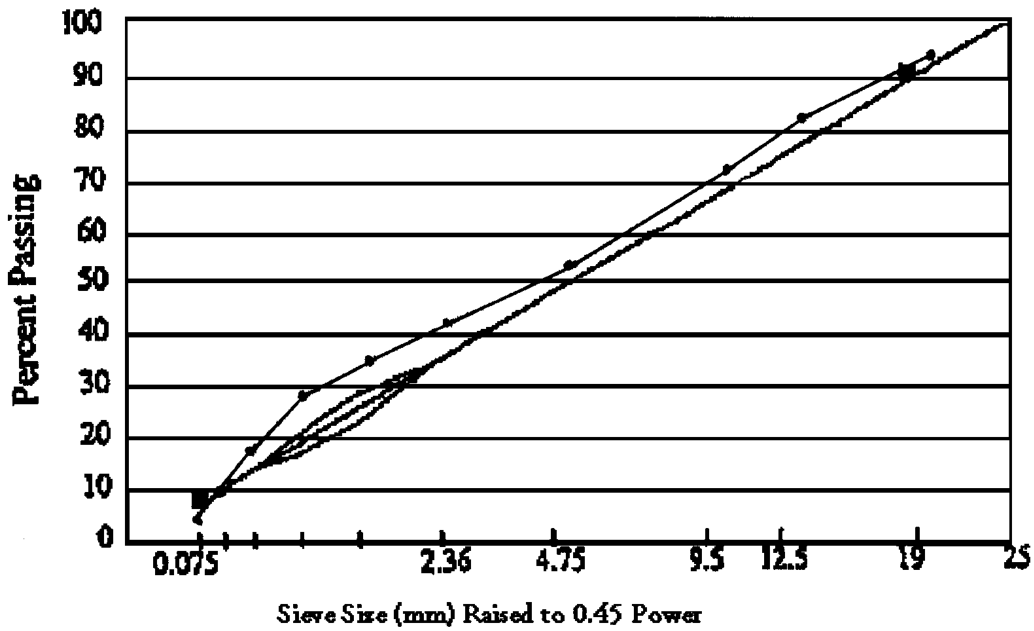

Figure 3-2 – Proposed JMF Gradation 0.45 Power Curve with Control Points

Note that when the mix tolerances are applied to the proposed JMF to determine the JMF Limits, a value cannot be reported that would be outside of the Control Points. For example, if the Proposed JMF value for the ½-inch sieve for this mixture were 86, then the topside value for the JMF Limit would be 89, not 93, since 93 would be outside the control points. For gradation purposes, all values are reported to the nearest whole number, with the exception of the Number 200 sieve size, which is rounded to the nearest tenth.

Chapter 3 of the Asphalt Institute's *Mix Design Methods for Asphalt Concrete and other Hot-Mix Types - MS-2* entitled "Evaluation of Aggregate Gradation" provides several examples of blending aggregates by weight to determine a specified gradation. In addition, a short discussion is provided on adjusting a composite blend to provide for sufficient void space. This section may assist the certified technician when confronted with a situation caused by insufficient VMA.

4 – Trial Mix Blends

The QC technician, following determination of the composite aggregate blend, will prepare trial blends of hot-mix asphalt with varying percentages of asphalt cement. These trial blends may be produced either in the design laboratory or the HMA plant. (Remember only hot-mix produced from a certified plant and with an approved JMF will be allowed on a DOTD project.) The type asphalt cement to be used is stipulated in Table 501-1 – Asphalt Cement Usage By Mixture Type.

The QC technician shall prepare a minimum of three trial blends with the proposed composite aggregate blend at three different trial asphalt cement contents. One of the blends shall be prepared at asphalt cement content near optimum (as defined by a specified air void content, V_a). A second trial blend shall be prepared at asphalt cement content approximately 0.5% less than optimum. A third trial blend shall be prepared at an asphalt cement content approximately 0.5% greater than optimum. Three specimens shall be prepared at each of the trial asphalt cement contents.

Chapter 5 of the Asphalt Institute's *Mix Design Methods for Asphalt Concrete and other Hot-Mix Types - MS-2* entitled "Marshall Method of Mix Design" outlines the steps required to prepare and document the trial blends. However, the mixing and compaction temperature shall be determined by the supplying asphalt cement supplier and will be printed on the Certificate of Delivery that accompanies each transport of asphalt cement delivered to the plant. (The traditional method of determining asphalt cement mixing and compaction temperatures, via a temperature and viscosity chart, is not valid for many of the polymer-modified asphalts now in use.)

After the trial blends have been prepared, each specimen (briquette) shall be tested for the following:

- Bulk Specific Gravity, G_{mb}
- Air Voids, V_a
- Voids in Mineral Aggregate, VMA
- Voids Filled with Asphalt, VFA
- Marshall Stability and Flow

In addition, the technician shall prepare a loose mix sample at each trial blend asphalt cement content and test them for maximum theoretical specific gravity, G_{mm} (Rice Gravity) using AASHTO T209. For laboratory produced trial blends, the mixture, when tested for G_{mm}, shall be cured at compaction temperature for approximately two hours prior to specimen preparation. Plant produced trial blends require a one-hour curing or aging period. When the aggregate water absorption is greater than 2%, the oven aging time for plant produced mix shall be increased to two hours.

The average test values of the three specimens at each asphalt content, assuming no statistical outlier, shall be averaged to report a single value. Should an outlier be identified, it shall be discarded and the other two results averaged.

The following definitions and nomenclature, as reported in MS-2 Chapter 4, “Volumetric Properties of Compacted Paving Mixtures,” are adopted by the department for use when analyzing and documenting hot-mix asphalt mixtures.

Mineral aggregate is porous and can absorb water and asphalt to a variable degree. Furthermore, the ratio of water to asphalt absorption varies with each aggregate. The three methods of measuring aggregate specific gravity take these variations into consideration. The methods are bulk, apparent and effective specific gravities. The differences among the specific gravities come from different definitions of aggregate volume.

- Bulk Specific Gravity, G_{sb} – The ratio of the mass in air of a unit volume of a permeable material (including both permeable and impermeable voids normal to the material) at a stated temperature to the mass in air of equal density of an equal volume of gas-free distilled water at a stated temperature. See Figure 3.3.

- Apparent Specific Gravity, G_{sa} – The ratio of the mass in air of a unit volume on an impermeable material at a stated temperature to the mass in air of equal density of an equal volume of gas-free distilled water at a stated temperature. See Figure 3.3.

- Effective Specific Gravity, G_{se} – The ratio of the mass in air of a unit volume of a permeable material (excluding voids permeable to asphalt) at a stated temperature to the mass in air of equal density of an equal volume of gas-free distilled water at a stated temperature. See Figure 3-3.

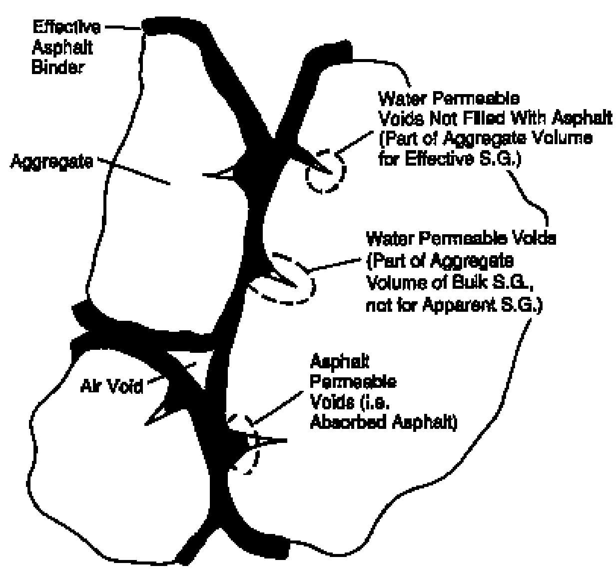

Figure 3-3 – Illustrating Bulk, Effective and Apparent Specific Gravities; Air Voids and Effective Asphalt Content in Compacted Asphalt Paving Mixture

- Voids in Mineral Aggregate, VMA– The volume of intergranular void space between the aggregate particles of a compacted paving mixture that includes the air voids and the effective asphalt content, expressed as a percent of the total volume of the sample. See Figure 3-4.

- Air Voids, V_a – The total volume of the small pockets of air between the coated aggregate particles throughout a compacted paving mixture, expressed as a percent of the bulk volume of the compacted paving mixture. See Figure 3-4.

- Voids Filled with Asphalt, VFA – The portion of the volume of intergranular void space between the aggregate particles (VMA) that is occupied by the effective asphalt. See Figure 3-4.

- Effective Asphalt Content, P_{be} – The total asphalt content of a paving mixture minus the portion of asphalt that is lost by absorption into the aggregate particles. See Figure 3-4.

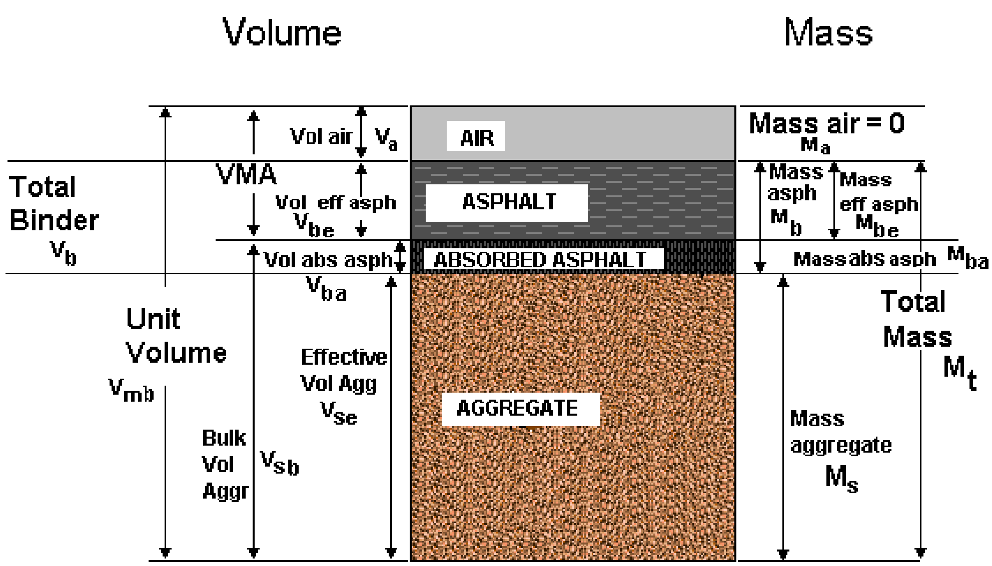

Figure 3-4 – Representation of Volumes in a Compacted Asphalt Specimen (Phase Diagram)

- Asphalt Cement Specific Gravity, G_b – The ratio of the mass in the air of a given volume of asphalt binder to the mass of an equal volume of water, both at the same temperature.

- Mixture Bulk Specific Gravity, G_{mb} – The ratio of the mass in air of a given volume of compacted HMA to the mass of an equal volume of water, both at the same temperature.

- Theoretical Maximum Specific Gravity, G_{mm} (Rice Gravity) – The ratio of the mass of a given volume of HMA with no air voids to the mass of an equal volume of water, both at the same temperature.

The following standard conventions are used to abbreviate asphalt cement (binder), aggregate and mixture characteristics:

Specific Gravity (G) – G_{xy}

x - b = binder
s = aggregate (for example, stone)
m = mixture

y - b = bulk
e = effective
a = apparent
m = maximum theoretical

Mass (P) or Volume (V) Concentration: P_{xy} or V_{xy}

x - b = binder
s = aggregate (for example, stone)
a = air

y - e = effective
a = absorbed

The VMA values for compacted asphalt paving mixtures are to be calculated in terms of the aggregate's bulk specific gravity, G_{sb}.

Voids in the mineral aggregate (VMA) and air voids (V_a) are expressed as percent by volume of the paving mixture. Voids filled with asphalt (VFA) is the percentage of VMA that is filled by the effective asphalt cement. The effective asphalt cement content shall be expressed as a **percent by weight of the total weight of the mixture.**

The following equations are used to compute the volumetric properties of compacted hot-mix asphalt specimens.

Bulk Specific Gravity of HMA Specimen G_{mb}:

$$G_{mb} = \frac{\text{Weight in Air}}{(\text{SSD Weight} - \text{Weight in Water})}$$

Air Voids, V_a:

$$V_a = 100 \times \frac{G_{mm} - G_{mb}}{G_{mm}}$$

Voids in Mineral Aggregate, VMA:

$$VMA = 100 - \frac{G_{mb} \times P_s}{G_{sb}}$$

Voids Filled with Asphalt, VFA:

$$VFA = 100 \times \frac{VMA - V_a}{VMA}$$

Effective Specific Gravity, G_{se}:

$$G_{se} = \frac{100 - P_b}{\frac{100}{G_{mm}} - \frac{P_b}{G_b}}$$

Percent Absorbed Asphalt, P_{ba}:

$$P_{ba} = \frac{(100 \times G_b)(G_{se} - G_{sb})}{G_{sb} \times G_{se}}$$

Percent Effective Asphalt Cement, P_{be}:

$$P_{be} = P_b - \left(\frac{P_{ba}}{100}\right) x\, P_s$$

Dust to Asphalt Ratio, D/P or D_{200}/P_{be}:

$$D / P = \frac{P_{200}}{P_{be}}$$

The certified technician shall report the volumetric and Marshall analysis results on the *Mix Design Worksheet* (Appendix Q) or an approved computer generated spreadsheet.

The QC technician shall plot the following relationships, as determined from these equations, on the department's *Optimum Asphalt Cement Content Summary of Test Properties* (Appendix V) or a similar, approved designed graph.

- Air Void (V_a) versus asphalt content
- Voids in Mineral Aggregate (VMA) versus asphalt content
- Voids Filled with Asphalt (VFA) versus asphalt content
- Marshall Stability versus asphalt content
- Flow versus asphalt content.

5 – Optimum Asphalt Cement Content

Examining the test property curves plotted on the department's *Optimum Asphalt Cement Content Summary of Test Properties* (Appendix V), information about the sensitivity of the mixture's volumetrics, as related to asphalt content, can be surmised. Trends generally noted are:

- The percent air voids, V_a, steadily decreases with increasing asphalt cement content, ultimately approaching a minimum void content.

- The percent voids in the mineral aggregate, VMA, generally decreases to a minimum value, then increases with increasing asphalt cement content.

- The stability value increases with increasing asphalt cement content up to a maximum after which the stability decreases.

- The flow value consistently increases with increasing asphalt cement content.

- The percent voids filled with asphalt, VFA, steadily increases with increasing asphalt cement content, because VMA is being filled with asphalt cement.

- The curve for unit weight of total mix, whose plot is not required for JMF submittal, follows the trend similar to the stability curve, except that the maximum unit weight normally occurs at a slightly higher asphalt content than the maximum stability.

The selected design asphalt cement content of the mixture is the percentage yielding the median percentage of air voids (4.0 percent for all mixtures except for Type 7L, it is 3.0 percent). The technician shall then evaluate all of the calculated

and measured mix properties at this asphalt cement content and compare them to the specified values in Table 501-3. If all of the design criteria are not met, then the QC technician shall make adjustments or redesign the mix.

The following discussion pertaining to VMA, V_a, and VFA is reprinted here from MS-2 to provide the certified technician with assistance in adjusting mixtures to meet these volumetric properties:

> *EVALUATION OF VMA CURVE: In many cases, the most difficult mix design property to achieve is a minimum amount of voids in mineral aggregate. The goal is to furnish sufficient space for the asphalt cement so it can provide adequate adhesion to bind the aggregate particles, but without bleeding when temperatures rise and the asphalt expands. Normally, the curve exhibits a flattened U-Shape, decreasing to a minimum value and then increasing with increasing asphalt content.*
>
> *This dependency of VMA on asphalt cement content appears to be a contradiction to the definition. One might expect the VMA to remain constant with varying asphalt cement content, thinking that the air voids would simply be displaced by asphalt cement. In reality, the total volume changes across the range of asphalt contents; the assumption of a constant unit volume is not accurate. With the increase in asphalt, the mixture actually becomes more workable and compacts more easily, meaning more weight can be compressed into less volume. Therefore, up to a point, the bulk density of the mixture increases and the VMA decreases.*
>
> *At some point as the asphalt cement content increases (the bottom of the U-Shaped curve), the VMA begins to increase because relatively more dense material (aggregate) is displaced and pushed apart by the less dense material (asphalt cement). It is recommended that* ***asphalt cement contents on the wet or right-hand increasing side of this VMA curve be avoided****, even if the minimum air void and VMA criteria is met. Design asphalt cement contents in this range have a tendency to bleed and/or exhibit plastic flow when placed in the field. Any amount of additional compaction from traffic leads to inadequate room for asphalt expansion, loss of aggregate-to-aggregate contact, and eventually, rutting and shoving in high traffic areas. Ideally, the design asphalt cement content should be selected slightly to the left of the low point of the VMA curve, provided none of the other mixture criteria are violated.*
>
> *In some mixtures, the bottom of the U-Shaped VMA curve is very flat, meaning that the compacted mixture is not as sensitive to asphalt cement content in this range as some other factors. In the normal range of asphalt contents, compactability is influenced more by aggregate properties. However, at some point the quantity of asphalt will become critical to the behavior of the mixture and the effect of asphalt will dominate as the VMA increases drastically.*

When the bottom of the U-Shaped VMA curve falls below the minimum criteria level required for the nominal maximum aggregate size of the mix, it is an indication that changes to the job-mix formula are necessary. Specifically the aggregate grading should be modified to provide additional VMA. ***The design asphalt cement content should not be selected at the extremes of the acceptable range even though the minimum criteria are met.*** *On the left-hand side, the mix would be too dry, prone to segregation, and would probably be too high in air voids. On the right-hand side, the mix would be expected to rut.*
If the minimum VMA criteria are completely violated over the entire asphalt cement content range (curve is completely below the specified minimum), a significant redesign and/or change in material sources is warranted.

EFFECT OF AIR VOIDS: It should be emphasized that the design range of air voids (3 to 5 percent except for Type 7L which is 2 to 4 percent) is the level desired after several years of traffic. This goal does not vary with traffic; the laboratory compactive effort is supposed to be selected for the expected traffic. This design air void range will normally be achieved if the mixture is designed at the correct compactive effort and the percent air voids after construction is about 8 percent. Some consolidation with traffic is expected and desired.

The consequence of a change in any factor or any detour in the procedure that offsets the total process will be a loss of performance or service life. It has been shown that ***mixtures that ultimately consolidate to less than three percent air voids can be expected to rut and shove*** *if placed in heavy traffic locations. Several factors may contribute to this occurrence, such as an arbitrary or accidental increase in asphalt cement content at the mixing facility or an increased amount of ultra-fine particles passing the No. 200 sieve beyond that used in the laboratory, which will act as an asphalt cement extender.*

Similarly, problems can occur if the final air void content is above five percent or if the pavement is constructed with over eight percent air voids initially. Brittleness, premature cracking, raveling, and stripping are all possible under these conditions.

The overall objective is to limit adjustments of the design asphalt cement content to less than 0.5 percent air voids from the median of the design criteria (4 percent for all mixtures, except for Type 7L which is 3 percent), especially on the low side of the range and to verify that the plant mix closely resembles the laboratory mixture.

EFFECT OF VOIDS FILLED WITH ASPHALT: Although VFA, VMA, and V_a *are all interrelated and only two of the values are necessary to solve for the other, including the VFA criteria helps prevent the design of mixes with marginally-acceptable VMA. The main effect of the VFA criteria is to* *limit maximum levels of VMA and, subsequently, maximum levels of asphalt cement content.*

VFA also restricts the allowable air void content for mixes that are near the minimum VMA criteria. Mixes designed for lower traffic volumes will not pass the VFA criteria with a relatively high percent air voids (five percent) even though the air void criteria range is met. The purpose is to avoid less durable mixtures in light traffic situations.

Mixtures designed for heavy traffic will not pass the VFA criteria with relatively low percent air voids (less than 3.5 percent) even though that amount of air voids is within the acceptable range. Because low air void contents can be very critical in terms of permanent deformation, the VFA criteria helps to avoid those mixes that would be susceptible to rutting in heavy traffic situations.

The VFA criteria provide an additional factor of safety in the design and construction process in terms of performance. Since changes can occur between the design stage and actual construction, an increased margin for error is desirable.

One of the most common problems when designing an HMA mixture according to MS-2 is providing sufficient VMA. Insufficient VMA can lead to inadequate space for asphalt cement. If all other factors remain constant, the fine aggregate fractions contribute more to VMA than the coarse aggregate fractions. However, the addition of natural sand to increase VMA is strongly discouraged. Should the maximum natural sand limit be surpassed, the mixture will not meet specifications. The rounded particles in natural sand, which include more inherent void space than manufactured, angular fine fractions, may also allow compaction to occur more easily and thoroughly. This can lead to a decrease in VMA, defeating the intended purpose. The filler material (particles passing the No. 200 sieve) is the aggregate fraction with the highest VMA due to its large surface area. These VMA values have been reported to be as high as 32 percent. However, adding more of these fines to the mixture can produce different VMA results, because of the wide variety of shapes and sizes found in these particles. In some cases, the extremely fine particles (less than 10 microns) may function as an asphalt cement extender, which would effectively cause the available VMA to decrease, not increase as desired.

VMA increases can be achieved by an overall adjustment of the gradation or possibly changing the shape or texture of the intermediate portion of the blended aggregates. Because of the interaction particle shape and texture on the packing characteristics of an HMA mixture, gradation changes (typically moving away from the maximum density line) are only reasonable with the same aggregate source. By adjusting the proportional percentages of the aggregates that substantially contribute to the intermediate sizes, the gradation curve can be revised to plot further away from the maximum density line. This shift will, in most cases, increase VMA. Extreme care, however, should be taken when shifting away from the maximum density line for coarse graded mixtures. An excessive shift may produce a very coarse, gap-graded blend that will lead to compaction and permeability problems.

Particle shape and texture can also make a difference. Changing the source of one aggregate may introduce a completely new interaction between all of the other aggregate particles. Specifically, changing the angular shape and texture of coarse aggregates by crushing, or switching from natural sands to more angular manufactured sands (or screenings), can implement a significant change in VMA. The same aggregate gradation with the same compaction effort, but with different shaped particles, can produce, in most cases, a different amount of VMA.

6 – Moisture Sensitivity Analysis - Lottman Test (Tensile Strength Ratio – TSR)

To complete the design process, the QC technician shall perform the moisture sensitivity test (the Lottman – AASHTO T 283) to evaluate the proposed hot-mix asphalt blend for stripping. This test is not a performance-based test, but serves two purposes. First, it identifies whether a combination of asphalt binder and aggregate is moisture susceptible. Second, it measures the effectiveness of anti-stripping additives.

Subsection 501.03(b) requires that mixtures containing conventional asphalt cement (PG 64-22 or PG 58-22 yield a minimum TSR of 75 percent for) and that mixes using modified asphalt cement (PG 70-22m or PG 76-22m) yield a TSR of 80 percent. In addition, the *Standard Specifications* require that the proposed JMF stipulate a single anti-strip rate, which is 0.1 percent greater than the percentage that will yield these TSR values up to a maximum of 1.2 percent. Appendix V depicts typical Lottman results and the form on which they are to be reported.

According to Subsection 501.03(b), after the department approves the JMF and production has begun, the DOTD inspector will also evaluate the mixture for moisture sensitivity according to AASHTO T 283. The inspector will conduct this Lottman verification in the plant laboratory during the first lot of production. The inspector will record the results on the TSR Form (Appendix V) and forward it to the district laboratory engineer.

7 – Permeability Testing

The QC technician shall perform permeability testing and report the results on the JMF Release Form. Permeability tests shall be performed on 6-inch diameter by 4-inch tall (150 mm x 100 mm) specimens, compacted to 93% ±1% of the theoretical maximum specific gravity (G_{mm}). The maximum coefficient of permeability shall be 3.5 feet per day (125×10^{-5} cm/second) as measured in accordance with ASTM PS 129-01. These same specimens may be used for moisture sensitivity testing.

8 – Submittal Process and Documentation – (JMF Release Form)

Once the optimum asphalt cement content has been determined for the proposed aggregate blend and the moisture sensitivity analysis (Lottman test) has been completed, then the certified technician submits the proposed job mix formula (JMF) to the district laboratory engineer. The JMF shall be submitted on a properly completed

Asphaltic Concrete Job Mix Release Form (Appendix W) or an approved computer generated form similar to the one furnished by the DOTD (Appendix Z).

Along with the Asphaltic Concrete Job Mix Release Form, the QC technician is to submit the following information for approval to the district laboratory engineer:

1. Mix Design Worksheet (Appendix S) with trial blends at three asphalt cement contents (0.5 percent below optimum, at or near optimum and 0.5 percent above optimum). Careful attention should be noted to ensure that SSD G_{mb}'s are correctly filled in along with G_{mm}'s.

2. Optimum Asphalt Cement Content Summary of Test Properties (Appendix W) showing VMA, V_a, VFA, Marshall Stability and Flow versus asphalt cement content.

3. Asphaltic Concrete Gradation Form (with restricted zone and control points) plotted to the 0.45 power with the proposed aggregate blend (Appendices R, S and T.)

4. Lottman results (from the laboratory or plant design) (Appendix V.)

The QC technician shall submit the original, signed JMF Release, along with the four supporting documents, to the district laboratory engineer for approval no less than 7 days before estimated date of production.

The district laboratory engineer must approve the job mix formula before any material can be produced for the department. Upon approval of the proposed JMF, the district laboratory engineer will give it a numerical identification (the JMF Sequence Number). This identification code must be clearly written, typed, or printed on the JMF Release Form and all supporting documentation.

9 – Approval of JMF Proposal

Upon approval of the JMF, the district laboratory engineer will sign the original in the "Proposal Approved" section at the bottom of the document, circle "Yes" and date it. The district laboratory will retain a copy and return the original to the plant pending validation.

10 – Validation of JMF Proposal

Once the JMF has been approved for validation, the plant may begin producing mixtures for the department according to the JMF. However, before the validation process begins for the approved JMF, the project engineer in charge of the project must verify that the mix type and project specifications for the project(s) receiving the mix are the same as the proposed mix design.

It is the responsibility of the QC certified technician to always provide the project engineer with a copy of the JMF prior to production for a particular project. (A facsimile copy will suffice for this task.)

JMF validation will be completed on the first production lot. This evaluation ensures that the mixture produced in the plant meets the tolerances set forth in the JMF Proposal. The contractor/producer and DOTD inspector perform JMF validation jointly. Validation will consist of a full set of tests for the first production lot, including four Marshall briquettes and two extracted gradations. The results of these tests must indicate that the mix is being uniformly produced in accordance with the design requirements. If at any point during the validation process, it becomes obvious that the mixture will not validate, the JMF will be disapproved.

The performance of the mixture on the roadway will also be evaluated to ensure that the JMF is not contributing to laydown deficiencies, such as segregation, tenderness, workability, compactability, or surface texture problems. Mixtures that are identified as causing any laydown deficiency will not be validated. The project engineer in charge of the project or the district laboratory engineer may determine that a proposed JMF is invalid for roadway deficiencies.

The volumetric properties reported on the JMF must be validated. The average volumetric properties of the four briquettes prepared during the validation lot shall be within those ranges specified in Table 501-3. Specifically, the VMA and V_a average shall be within the stipulated range for the mixture type and nominal aggregate size used.

The extracted gradation average of the two single extractions, performed according to TR 323 and TR 113, shall be within the JMF limits shown on proposed JMF. During the validation process the QC technician may adjust any sieve above and including the No. 50 by ± 2.0 percent. The technician may also adjust the No. 200 by ±1.0 percent. These changes, if required, shall be neatly inked in on the original JMF.

The extracted gradation shall also be checked to determine the percent crushed material in accordance with DOTD TR 306 (for mixtures containing coarse aggregates other than crushed stone). This percentage must also be within the specification limits as set forth in Table 501-3.

Mix designs on the borderline of the JMF limits are subject to rejection by the district laboratory engineer if the tolerances are exceeded during future production on DOTD projects.

Additionally, if the mixture exhibits uncoated aggregate or possible moisture problems, the QC technician and department inspector will perform **AASHTO T195 (Ross Count) to ensure that the mixture meets the 95 percent coating requirement of the specifications (Subsection 503.02(m)) or TR 319 to ensure that the moisture content of the mixture does not exceed the 0.5 percent specification requirement.**

If a mix design fails to validate, a new proposal must be submitted and validation testing repeated. No mixture shall be produced for a DOTD project until the district laboratory engineer has approved a new JMF Release proposal.

Although the department provides tolerances for mix properties, it is not intended that the mixture be produced randomly with these ranges. It is expected that the mixture exhibit a consistent and uniform gradation, be produced at the optimum asphalt content determined by the mixture design, and include the percent anti-strip indicated on the JMF.

Mix produced during the validation process will be accepted in accordance with the proposed JMF and Table 501-5 (Payment Adjustment Factors). If production is discontinued because a mixture will obviously not validate, the size of this initial production lot will be modified to the actual tonnage produced during the validation period.

If the JMF does not validate, the district laboratory engineer will indicate disapproved on the proposed JMF Release, enter the sequence number, date and sign it (disapproved). Copies of the disapproved JMF Release will be distributed to each project engineer who received a portion of the lot.

In review, the following is required for JMF validation:

- Four Marshall Briquettes (VMA, V_a, Stability, and Flow) within specification range (Table 501-3 and Proposed JMF).
- Two Gradations within specification range (Table 501-3 and Proposed JMF).
- Aggregate Coating within 95 percent requirement (AASHTO T 195).
- Moisture Content within 0.5 specification limit (TR 319).

The validation data is entered on the JMF and reviewed by the department's inspector who will forward it to the district laboratory engineer (Appendix AA.)

11 – Final Approval of JMF

The district laboratory engineer, upon receipt of the validated JMF, will sign and date the document for a second time on the "Approved" line. Copies of the approved mixture design will then be returned to the plant laboratory.

Once a completed mixture design has been approved and validated, the same JMF may be used for all projects having the same specification requirements.

It is the responsibility of the QC technician to provide the project engineer (in charge of a project anticipating receiving mix from the plant) with a copy or facsimile of the Job Mix Formula (cover sheet only) prior to production.

The district laboratory engineer will provide the contractor, producer, department plant personnel, and the project engineer who is receiving the mixture with an approved copy of the mixture design for project records.

QC TECHNICIAN – RESPONSIBILITIES

The primary responsibilities of the QC technician are to design hot-mix asphalt mixtures and control their production to ensure that they uniformly and consistently meet LA DOTD requirements.

The technician shall be at the plant for the beginning of daily operations. Whenever HMA mixtures are being produced for a DOTD project, a certified technician must be either at the plant or the paving site.

It is the certified technician's responsibility to perform all tasks necessary to begin plant operations. This includes, but is not limited to, checking asphalt cement working tanks, material stockpiles, aggregate bins, cold feed settings, meters, and scales. The certified technician is responsible for recommending appropriate adjustments and ensuring that these adjustments have been made during continuing operations to ensure uniformity and conformance to specifications.

In addition, the certified technician shall oversee and monitor the complete production, transport, placement, and compaction phases to ensure compliance with minimum standards and to promote consistency. It is imperative that the technician use experience and common sense to analyze problem situations.

The certified technician shall be cognizant of proper plant operations and be aware of moisture inconsistencies. When the plant is put into operation, the technician shall monitor stockpiles to ensure that they are constructed properly and that moisture contents entered into the plant controls are consistent with actual values for each material bin.

Plant operations should be continuously inspected to ensure the following:

- Proper bag house operation (startup and shutdown loads will be impacted by improper sequence of fines return from the dust collection system producing material with inconsistent amounts passing the No. 200 sieve).

- Sufficient HMA is wasted at startup and shutdown to ensure adequate, sufficient, and consistent asphalt cement rates.

- Proper loading of trucks to minimize effects of material segregation.

Proper sampling is crucial for accurate results that represent actual plant production. The QC technician can take independent samples or can use unused quarters of samples taken by departmental personnel.

Gradation

Subsection 501.03(c) states that "for control purposes, the contractor shall obtain a minimum of two samples of mixture and tests will be performed for extracted gradation (TR 309), percent crushed (TR 306), and asphalt cement content (TR 323) for each lot." These specified QC requirements are only the minimum required and do not release the certified technician from performing any additional tests to ensure that materials consistently meet specifications.

The minimum required two gradations are to be randomly taken during the lot production. When the results of two consecutive gradation tests fall outside the job mix formula limit, the producer shall immediately make corrections to keep the mixture within the specified limits. Failure to keep the mixture within the specified limits shall result in the producer being prohibited from supplying the mixture to DOTD projects using that JMF. Further, when the results of two consecutive gradations on the No. 200 sieve fall within 0.5 percent of the approved job mix formula gradation limit or fall erratically within the range, the producer shall immediately make corrections. The contractor may use the DOTD acceptance gradation, if the test is performed at the plant, for one of the quality control points.

The technician should also, at regular intervals, check to ensure that the aggregate proportioning system is in calibration. This may be a two-step process. First, after the plant production has ceased, the weighbridge is checked to ensure that it is in calibration. This may be determined by running a known mass of material over it and correcting the weighbridge factor to get it into calibration over the full span of expected weights. Secondly, once the weighbridge has stabilized, each feeder bin may be stopped, during normal operations, for 10 to 15 seconds to determine if the proper mass of material/per unit time is being proportioned from the individual bin. This type of quick check is typically referred to "checking the calibration on the fly." However, this type of "on the fly" check is only accurate if it is known that the master weighbridge is in correct calibration.

There are other methods for checking cold feed calibrations, such as that in DOTD's publication *Cold Feed Adjustments for Asphaltic Concrete Plants*. In any method used, the measured weight of the aggregate includes moisture in the aggregate. Moisture content (MC) is calculated by the following equation.

$$\text{M.C.\%} = \frac{(\text{Weight Weight} - \text{Dry Weight})}{\text{Dry Weight}} \times 100$$

Therefore, to determine the *dry* weight, knowing moisture content, the following equation may be used:

$$\text{Total Dry Weight} = \frac{\text{Total Wet Weight} \times 100}{100 + \text{M.C.\%}}$$

All cold feed bins shall be provided with indicators to show the gate opening in inches. Further, each bin opening shall be rectangular, with one dimension adjustable by positive mechanized adjustment with a locking system Should the extracted gradation begin to fluctuate, then the aggregate proportioning system should be immediately checked along with individual stockpile gradations.

Asphalt Cement Content

The asphalt cement content may be determined two ways. The Ignition Oven (TR 323), required by specification, may be used along with a correction factor. Also, the rate of asphalt cement delivery is continuously shown, in digital form, on all modern plant controls. If these two values differ significantly, then the correction factor for the ignition oven needs to be reevaluated or the plant asphalt cement metering systems needs to be recalibrated. The latter is done with a quantity of asphalt cement metered into a tanker or tank that can be readily weighed on a set of calibrated scales or load cells. Note that excess moisture in the mix may falsely appear as asphalt cement during the Ignition Oven test procedure and it may also artificially lower the G_{mm} and artificially increase the G_{mb}.

Laboratory Volumetrics

The QC technician shall conduct quality control tests to ensure that volumetrics are within specification range. This will require that the technician prepare and compact Marshall briquettes and test them for specific gravity (AASHTO R 12) along with a companion loose mix sample for maximum theoretical gravity testing, G_{mm} (AASHTO T209). The QC technician shall perform as many tests as necessary to ensure the mix is in continuous compliance with the approved JMF.

Additives

The QC technician shall also check the rate of anti-strip at the beginning of each operational period, and when necessary thereafter, to ensure that the mixture is receiving the JMF percent of anti-strip. If used, the QC technician shall also check the mineral filler or lime at the beginning of each operational period, and when necessary thereafter, to ensure that the mixture is receiving the JMF percent of additive.

Temperature

Temperature of the asphalt cement and of the hot-mix asphalt is very critical. It is also critical that the temperature of these two products consistently be as specified. Specific attention should be given to monitoring temperature in all asphalt cement working tanks to ensure that all materials added, particularly from transports, are also at the correct elevated temperatures. Temperature is directly correlated with viscosity, which will affect the material's ability to adequately coat the aggregate.

Specifications require that a thermometer be provided to indicate mixture discharge temperature (typically at the discharge of the dryer/drum). Mixture temperature consistency is essential in obtaining consistent roadway compaction. The technician may check this thermocouple temperature against either an infrared gun-type thermometer device or by using a standard, calibrated dial thermometer.

The JMF stipulates an optimum mixing temperature range, which is ±25° F of the optimum mixing temperature for the asphalt cement used (as supplied by the refinery). The discharge temperature should always be within this range. Mixing temperature must never exceed 350° F, regardless of the supplier's recommendation. Further, Subsection 501.07 of the *Standard Specifications* states that no mixtures shall be delivered to the paver cooler than 25° F below the lower limit of the compaction temperature as shown on the JMF. The temperature of the mix going through the paver shall not be cooler than 250°F. Five, randomly determined, portions of the lot shall be selected for temperature checks. These temperature checks shall be taken from the dryer/drum discharge chute thermocouple and recorded by the DOTD inspector on the Asphaltic Concrete Plant report form (QA copy) (Appendix AB) along with the accumulated lot tonnage corresponding to the time when the temperature was noted and recorded.

Moisture

Stripping of asphalt mixtures will not occur in the absence of moisture or moisture vapor. To approach this ideal state, all hot-mix asphalt materials should be produced in a manner that minimizes internal moisture, which can weaken the molecular bond between the asphalt cement (binder) and the mineral aggregate.

However, with the average annual rainfall and humidity present in Louisiana, it is difficult to remove all free and absorbed moisture from aggregate in the HMA production process. In a typical plant, when fuel is burned, a quantity of heat is produced. This heat is transferred to the aggregate to evaporate moisture and heat the aggregate. As moisture in the aggregate evaporates, each pound of water expands to 33 cubic feet of steam. This enormous volume of steam must be removed by the plant's exhaust system. Hence, when aggregate moisture values increase (as in the presence of recent rainfall) the plant's production rate and burner settings must be adjusted to maintain and achieve consistent mixture temperatures and remove sufficient moisture. The drum mixer should also be routinely inspected for excessive flight wear. Excessively worn or missing flights will greatly affect the plant's ability to heat and dry aggregates.

The presence of moisture also aggravates the process of accurately measuring mixture volumetrics. Excessive moisture in hot-mix asphalt may lead to an abrupt collapse in voids in mineral aggregate.

The certified technician, as part of the Quality Control Plan, should continually monitor the moisture in the individual aggregate stockpiles (TR 403) and of the loose hot-mix asphalt (TR 319).

Documentation

The QC certified technician shall keep, as a minimum, the following records on file at the plant laboratory:

1. An Asphaltic Concrete Plant Report form (Appendix AB) for each lot showing two extracted asphalt contents, gradations, and percent crushed values for the lot. These gradations, asphalt cement contents, and percent crushed test results shall be entered on the QC copy of the Plant Report form.

2. The QC technician shall determine the discharge mixture temperature (recorded from the dryer/drum discharge thermocouple) five times randomly throughout the lot. These temperatures, along with the accumulated tonnage they represent, shall be reported on the QC copy of the Asphaltic Concrete Plant Report form (Appendix AB).

3. Asphaltic Concrete Control Charts (Appendix AC).

For control purposes, the QC technician shall plot individual results for percent asphalt cement (TR 323), extracted gradation (TR 309), air voids (V_a), and theoretical maximum specific gravity (G_{mm}) (T 209) on Asphalt Concrete Control Charts. The percent passing for each screen as indicated on the job mix formula shall be entered in the field labeled "JMF ________%." The upper and lower limits for the JMF must be clearly shown on each graph. When the control charts show a trend in the mix toward the JMF limits, the contractor/producer shall immediately take steps to prevent the mix from moving outside the JMF limits. It is the department's intent that the mixture produced correspond to the JMF. Results that are within tolerances, but vary erratically within these tolerance limits, indicate that the plant is not producing a uniform mixture. If the control charts show that the mixture being produced is not uniform, the contractor shall correct operations and produce a uniform mixture or discontinue operations for the DOTD. When the results of two consecutive extracted gradation tests on any sieve fall within 1 percent of the approved JMF limit, the contractor/producer shall immediately make corrections to keep the mixture within specified limits. Failure to keep the mixture within specified limits shall result in the contractor/producer's being prohibited from supplying this mixture to DOTD projects.

All corrections made by the contactor to control the mixture and prevent any aspect of the mixture from moving outside specified limits or from varying erratically within those limits shall be documented on the back of the control chart. This documentation shall include the action taken, date and time and be initialed by the QC technician. If the test results for any control chart cannot be plotted in the space provided on the control chart, the technician shall document the corrective action taken on the back of the chart. **The control charts shall be maintained per plant lot per job mix.**

The QC technician is to document all quality control (QC) testing and keep these records on file at the plant laboratory. The Certified Technician shall stamp all QC documents "QC" with red ink, in minimum one-inch high letters.

DOTD CERTIFIED INSPECTOR - RESPONSIBILITIES

The DOTD certified inspector is the department's official representative at the plant. The DOTD certified inspector is responsible for the following:

- Ensuring that the QC technician performs all tasks required

- Checking the QC program to ensure that it is in conformance with department requirements

- Ensuring that, through inspection sampling and testing, the HMA product meets all department standards.

The DOTD inspector is also responsible for ensuring that material samples for department testing are obtained in accordance with prescribed testing schedules and frequencies, that all samples are representative of the material, and that the samples are submitted, along with appropriate forms and documentation, to the appropriate testing facility in a timely manner. Additionally, the DOTD Certified Inspector is responsible for performing acceptance tests on the product as required by DOTD.

Subsection 501.12(b) of the *Standard Specifications* outlines the tests to be performed by the DOTD inspector for acceptability of the hot-mix asphalt. These tests are performed at the plant unless directed otherwise by the laboratory engineer. These acceptance tests are listed below:

- Extracted Gradation (No. 8 and No. 200 – Payment Factor Applied)
- Percent Crushed Aggregate
- Percent Asphalt Cement
- Asphalt Cement Properties (Payment Factor Applied) (Tested by DOTD Materials and Testing Section)
- Percent Anti-Strip (Payment Factor Applied)
- Air Voids, V_a
- Voids in Mineral Aggregate, VMA
- Voids Filled with Asphalt, VFA
- Theoretical Maximum Specific Gravity, G_{mm}
- Marshall Stability (Payment Factor Applied)
- Flow
- Moisture in Loose Mix
- Pavement Density

In addition, testing for surface tolerance (profilograph) will be required for each lot on the final roadway wearing course and airport wearing course lift. The department's and the contractor's Authorized Profilograph Operators and Evaluators will be responsible for the determination of these surface smoothness values.

Gradation (Extracted Gradation and Percent Crushed Aggregate) – Payment Factor Applied

- The DOTD certified inspector, for the purpose of gradation acceptance testing (TR 323 and TR 113/112), will sample the loose HMA mixture. The inspector will take two loose mix sample, randomly spaced throughout the production lot. Samples will be taken in accordance with DOTD Designation S203 in the *Materials Sampling Manual*

The DOTD Certified Inspector will test the samples, or if directed by the district laboratory engineer, will send them to the district laboratory to be tested. One sample will be tested and if the test results are within the specification limits, no payment adjustment will be made and the remaining sample will be discarded. When test results from one sample are outside the JMF control limits, the remaining sample for the lot will be tested. Deviation of gradation will be calculated for each test. The deviations will be averaged for determination of adjustments in unit price in accordance with Table 501-5. The results from one or two extracted gradations are to be entered on the QA copy of the Asphaltic Concrete Plant Report Form (Appendix AB).

This adjustment in unit price is determined by percent deviation from JMF control limits for the Number 8 and Number 200 sieve sizes and **only the sieve with the greatest adjustment in unit price will be used.**

An example of applying payment adjustment factors for extracted aggregate gradation is as follows:

Lot 105 = 1010 tons of Type 8 Wearing Course

Mix delivered to the following projects:

Project A = 506 tons
Project B = 463 tons
Project C = 41 tons

Sieve 8 JMF Limits = 52 to 64
Sieve Test Results for Sample Number 105-B = 67
Deviation = 3

The QC technician will be notified immediately that the one sample (105-B) is not in the JMF limits on the Number 8 sieve. The DOTD Certified Inspector will check the Control Charts at the plant.

Sieve Test Results for Sample Number 105-A = 63
Deviation = 0

Average of the two deviations = (3 + 0)/2 = 1.5

The tonnage received by all projects (A, B and C) from the lot represented by this example would be paid at 98 percent of the contract unit price, based on the results of extracted gradation testing. Table 501-

5 specifies that a 1.1 to 2.0 average deviation on the Number 8 sieve size results in a 98% payment of contract unit price.

One of the two lot samples is out of specification limits. Particular attention must be paid to gradation test results on subsequent lots.

The results of other tests which determine pay adjustments could reduce the final percent payment for the lot since **the lowest percentage of contract price will be used for final adjustment in unit price for deficiencies in Marshall stability, pavement density, surface tolerance, aggregate gradation and anti-strip.**

Percent Crushed Aggregate and Percent Asphalt Cement

During the testing of the sample (or samples) for extracted gradation, the percent crushed aggregate (TR 306) and percent asphalt cement (Ignition oven – TR 323) shall also be determined.

A correction factor is necessary to adjust the actual asphalt cement content when performing TR 323. The DOTD Correction Factor form, for use with the Ignition Furnace/Oven, is shown in Appendix AH. **Determination of a new correction factor will not be required when using a JMF that is identical to another, with only a change in asphalt cement grade from the same source or a change in source of the same grade. If aggregate breakdown is observed, a gradation correction may be made by comparing the bin pull gradations to the oven extracted gradations.**

Results of acceptance for percent crushed and percent asphalt cement will also be documented on the QA copy of the Asphaltic Concrete Plant Report form (Appendix AB).

In addition, the Certified Technician will, twice per lot, determine the percent asphalt cement from the plant meters/scales and report these two values on the QA copy of the Asphaltic Concrete Plant Report form (Appendix AB). If the asphalt cement content from the meter or scales does not fall within ±0.1% of the optimum AC on the JMF, the DOTD inspector will make a second determination immediately. If these results indicate continued lack of conformance to the required %AC, the producer shall discontinue operations for DOTD projects until the process has been corrected to the satisfaction of the district laboratory engineer.

Asphalt Cement Properties – Payment Factor Applied

Shipments of asphalt cement will be sampled and tested in accordance with the requirements of Section 501 of the *Materials Sampling Manual.* These samples shall be clearly marked with the following:

- Plant MATT Code (e.g., H312)
- Asphalt Cement Type
- JMF Number
- Lot Number

Appendix AF and AG show copies of the required asphalt cement and performance graded asphalt cement submittal forms, which shall accompany each sample of asphalt cement when submitted to the district laboratory.

The district laboratory will test one sample for dynamic shear (TP 5). Should this sample fail TP 5, the district laboratory will promptly notify the project engineer and the QC certified technician so that the producing refinery can be informed. Then, the second sample is submitted to the Materials and Testing Section for the full range of tests (see Table 1002-01 – Performance Graded Asphalt Cement). Results from this testing will determine the payment factor for asphalt cement properties. **Any pay reductions resulting from failing test results will apply to the theoretical quantity of HMA determined from the quantity of failing asphalt cement and shall be independent of any other quality assurance pay penalties.**

Percent Anti-Strip – Payment Factor Applied

An anti-strip additive shall be added to all mixtures at no less than the minimum rate determined in accordance with AASHTO T 283, at a rate not below 0.6 percent nor above 1.2 by weight of asphalt, in accordance with Subsection 501.03(b). The department's inspector will test for the amount of anti-strip at a frequency of twice per lot. The lot will be divided into two approximately equal sublots. If the percentage of anti-strip added to the mixture is not in accordance with the minimum required on the JMF, a payment adjustment factor will be applied to the lot in accordance with Table 501-5 – Payment Adjustment Schedules. If the check performed indicates that the amount of anti-strip added is not in accordance with the JMF, the producer must make adjustments so that the correct amount of anti-strip additive will be added to the mixture. If the second check indicates that the mixture is still not receiving the correct percentage of anti-strip, production for DOTD projects will be terminated until adequate adjustments can be made to the system or the system can be recalibrated.

An example of applying payment adjustment factors for deficient anti-strip is as follows:

> Assume that the minimum percent anti-strip (%AS) that will yield 80 percent TSR is 0.5 percent. Accordingly, the JMF then establishes 0.6% as the percentage of anti-strip to be incorporated in the mixture. Therefore the contractor is allowed to operate between 0.5% to 0.7% anti-strip.
>
> Upon inspection, the DOTD's inspector checks the AS meter and determines that the mixture produced since the last check (573 tons) has received only 0.3%.
>
> The 573 tons produced at this percent anti-strip will cause an adjustment of the contract unit price for the lot, in accordance with Table 501-5. The computation of this penalty will be as follows:
>
> The test, which represented one-half of the lot, indicated that the half-lot received only 0.3% AS, which results in 95 percent pay for that half-lot. The test for the second half lot indicated that the mix received 0.6% AS,

which results in 100 % payment for the second half lot. Therefore, to calculate the payment adjustment for this lot:

$$\text{Payment Adjustment} = \frac{(\%\text{pay for } 1^{\text{st}} \text{ half of lot}) + (\%\text{pay for } 2^{\text{nd}} \text{ half of lot})}{2}$$

$$\text{Payment Adjustment} = \frac{(95 + 100)}{2}$$

$$\text{Payment Adjustment} = 97.5 \text{ or } 98 \text{ percent}$$

All projects receiving mixture from this lot will be assessed a payment adjustment. This may not be the final percent pay for a project since the lowest percentage of contract price will be used for final adjustment in unit price for deficiencies in Marshall stability, pavement density, surface tolerance, aggregate gradation, and anti-strip additive.

The results of the percent anti-strip are entered on the Asphaltic Concrete Plant Report Form (Appendix AB). These readings are to coincide as closely as possible to approximately each half of a plant lot.

The basic method of checking the percentage of anti-strip in the mixture is to monitor the flow of additive for a continuous time sufficient to represent approximately half a lot. In order to proceed with the calculations for the percentage of anti-strip, the technician must know the unit weight of the anti-strip additive at any given temperature. The anti-strip supplier must make the unit weight information available or the inspector will weight a one-gallon sample at the plant to determine this value.

An example of determining percentage of anti-strip added to HMA is as follows:

1. Read and record the temperature of the anti-strip additive being added to the mixture from the thermometer on the anti-strip tank.

2. Take an initial reading of the amount of anti-strip additive from the anti-strip meter. Record the reading to the nearest readable increment (0.1 gallon or 0.25 gallon). Allow the plant to run for a continuous period of time sufficient to represent approximately half a lot. Take a final reading to the nearest readable increment and record.

3. Subtract the initial reading from the final reading to obtain the actual amount of anti-strip used during the time period.

4. Take an initial reading from the asphalt cement totalizing meter and record to the nearest gallon. (Some plants will digitally display the weight of asphalt cement added on the computerized operational controls.) Allow the plant to run for the same period of time as used for AS determination. Take a final reading of AC used and record to the nearest gallon. Subtract the initial reading from the final reading to obtain gallons AC used. **It is required that the percent asphalt cement and the percent anti-strip be checked simultaneously during**

continuous production to evaluate the quality of the mixture in terms of both components.

Calculate the percent anti-strip in terms of the weight of asphalt cement in pounds using the following formula:

$$\% \text{ AS} = \left(\frac{\text{pounds of anti} - \text{strip}}{\text{pounds of asphalt cement}} \right) x\, 100$$

Calculate pounds of anti-strip:

Unit weight of anti-strip	= 7.28 lb/gal (from curve)
Gallons anti-strip used during check	= 41.25 gal

7.28 lb/gal x 41.45 gal = 301.75 lb

Calculate pounds of asphalt cement:

Gallons AC used during check	= 5820
Weight of 1 gallon of water	= 8.34 lb/gal
Specific Gravity of AC @ 60°F	= 1.03

5820 gal x 8.34 lb/gal x 1.03 = 49,994.964 lb

Calculate the percent anti-strip:

$$\% \text{ AS} = \frac{301.75\, x\, 100}{49{,}994.964}$$

= 0.601

= 0.6 % anti-strip

Report the final percentage of anti-strip additive to the nearest 0.1 percent.

If lime or another other additive is being proportioned in the HMA mixture at the plant then this rate shall also be determined twice per lot, via the plants meters/scales, and shown on the QA copy of the Asphaltic Concrete Plant Report form (Appendix AB).

Air Voids (V_a), Voids in Mineral Aggregate (VMA), Marshall Stability & Flow

Testing of Volumetrics (V_a and VMA) and Marshall properties for acceptance purposes will be conducted at a rate of four tests per lot from samples taken randomly after the mixture is placed in trucks. One sample will be taken from each of the four sublots. The temperature of the mixture in the truck, at the time of sampling, shall also be recorded on the department's copy of the Asphaltic Concrete Plant Report form (Appendix AB).

The samples (briquettes) will be prepared in accordance with MS-2. In accordance with TR 305, mixtures are to be cured one hour in the compacting mold, at the compaction temperature of the asphalt cement used, prior to compaction. If any aggregates in the mixture have a water absorption greater than 2.0% then the aging time shall be 2 hours.

After the briquettes have cooled to room temperature, the inspector will test for specific gravity, G_{mb}. There are two G_{mm} tests required per lot. The first G_{mm} is taken from the first half of the lot and the second G_{mm} is taken from the second half of the lot. The first G_{mm} value will be used in determining volumetrics for the first and second briquettes; the second G_{mm} is used in determining volumetrics for the third and fourth briquettes. The average G_{mm} will be used in determining roadway density for the lot.
Following volumetric determination, the briquettes will be tested for Marshall stability and flow. The results of the volumetric analysis, Marshall stability and flow testing will be reported on the QA copy of the Asphaltic Concrete Plant Report form (Appendix AB).

The test results for volumetrics and flow shall be in accordance with the JMF. The test results for Marshall stability must be in accordance with Table 501-5 Payment Adjustment Schedules and the JMF. If any results are out of the JMF limits, immediate corrections shall be made or operations for DOTD projects shall be discontinued.

There is a payment adjustment attached to the values for Marshall Stability. When an individual test or the average of tests representing the lot is outside acceptance limits for stability shown in Table 501-5, an adjustment in contract unit price for the lot will be made in accordance with Table 501-5.

An example of determining percent payment for Marshall Stability is as follows:

Lot 105 = 1010 tons of Type 8 Wearing Course

Mix delivered to the following projects:

Project A = 506 tons
Project B = 463 tons
Project C = 41 tons

Marshall Stability Test Results for Lot 105:

Briquette 1	1472	Briquette 2	1875
Briquette 3	1990	Briquette 4	2025
	Lot Average: 1840		

Because Briquette 1 falls below 1500 (Table 501-5), the tonnage in the lot represented by this example would be paid for at 98 percent of the contract unit price. This payment adjustment will apply even though the lot average (1840) is above the specified lot average of 1800. This unit price adjustment will apply to all projects (A, B and C) receiving mixture from this lot (number 015).

The results of other tests which determine payment adjustments could reduce the final percent payment for the lot since **the lowest percentage of contract price will be used for final adjustment in unit price for deficiencies in Marshall stability, pavement density, surface tolerance, aggregate gradation and anti-strip additive.**

Two briquettes shall be submitted to the district laboratory per lot for verification.

Maximum Theoretical Specific Gravity, G_{mm} – "Rice Gravity"

The DOTD Certified inspector will perform tests for theoretical maximum specific gravity, G_{mm}, in accordance with AASHTO T 209. The G_{mm} will be determined for each of the two sublots. The G_{mm} for each sublot will be used in determining volumetrics, and the average of the two G_{mm} values will be used for roadway density. These G_{mm} values will be recorded on the QA copy of the Asphaltic Concrete Plant Report form (see Appendix AB) in the "theoretical gravity" area.

Moisture in Loose Mixture

DOTD personnel will determine the percent moisture in the loose mixture (TR 319) a minimum of once per lot and report the results on the QA copy of the Asphaltic Concrete Plant Report form (Appendix AB). The moisture content of the HMA will also be recorded on the DOTD Moisture Content of Asphaltic Concrete form (Appendix AI).

Pavement Density

Upon completion of compaction procedures, QC personnel shall obtain 5 pavement samples from each portion of the lot (one per sublot). The contractor/producer shall immediately fill and compact all core holes with asphaltic concrete or cold mix.

The contractor/producer shall take samples within 24 hours after placement of the mix, unless this deadline falls on a day that the contractor's crews are not working. In this case, samples shall be taken within 3 calendar days. For patching or widening operations, this time limit may be extended until the HMA has cooled sufficiently for coring to proceed.

The DOTD inspector will divide the lot portion into five sublots of approximately equal length; one sample shall be obtained from each sublot. Each portion of a lot placed on a given project (per use) will always be represented by exactly five samples for pavement density testing, with the exception of small quantities and patching and widening operations.

DOTD's Certified Paving Inspector will select sampling locations for pavement density cores by application of the Random Number Tables (DOTD S605 in the *Materials Sampling Manual)*. If a sampling location falls within one foot of an unsupported edge of the pavement, within 50 feet of a joint or structure, or within an obviously bad spot that is to be replaced, the inspector will select another sampling location through the reapplication of the Random Number Table. Cores of pavement widening are required. The DOTD Certified Paving Inspector will provide the contractor/producer coring representative with a list of the coring stations (with transverse dimension). The cores shall be taken within 5 feet of each selected location.

If a density sample is damaged as a result of the coring process the contractor/producer may request that another core be taken. It is the responsibility of the DOTD Certified Paving Inspector to select another sample location. The sample location must fall within a distance no greater than five feet from the location of the original sample, longitudinally up or down the station. Once the contractor/producer coring representative has reviewed the condition of the sample before testing and agreed it is not damaged, any future objections shall be invalid.

Since pavement density must be compared to the theoretical maximum density (G_{mm}) for the lot, the core samples must be clearly identified by lot number. The date the samples are taken will be recorded on the Asphaltic Concrete Pavement Report (Appendix AD). If the sample obtained from a pavement sublot is less than 1 3/8 inches thick, the DOTD Certified Paving Inspector will reject the core and select another sampling location for that sublot by reapplication of the Random Number Tables. The DOTD inspector will determine the core sample's official measurement by taking three measurements spaced uniformly around the circumference of the core. These measurements will be taken to the nearest 1/8-inch. The average of these measurements will be considered the official measurement. The DOTD inspector will record the official measurement, to the nearest 0.01-inch, on the Asphaltic Concrete Pavement Report (Appendix AD).

HMA mixtures placed in design layers less than 1 3/8 inches thick shall be compacted by approved methods to the satisfaction of the project engineer and shall not require coring.

The Certified Paving Inspector will inspect the cores for acceptability and label them for identification. Approved styrofoam transport containers for cores, provided through the district laboratory, are to be used to transport the cores to the testing contactor/producer's laboratory. Cores and transport containers are to be handled in accordance with Subsection 502.09. Any evidence of tampering with the core wrappings or of opening the container will result in the cores being rejected.

It is intended that cores be delivered to the plant on the same day as they are taken, so that the results for acceptance and verification can be made available to the project engineer in a timely manner.

The inspector will evaluate the five cores for bulk specific gravity, G_{mb}, (AASHTO T 166), and compare their results to the theoretical maximum specific gravity, G_{mm}, reported for the lot. The percent G_{mm} determined for each pavement sample will be averaged to calculate an average density for the lot. Specific attention should be given to ensure that the pavement cores are sufficiently free of moisture. This shall include placement of the cores in a force draft oven at 125°F until a constant mass is ensured as per AASHTO T

166. Constant mass is defined as the mass at which further drying at 125° F does not alter the mass by more than 0.05 percent. **For permeable mixtures, this error can be significant.**

If mix from the same lot is used for two different applications (i.e., roadway and shoulder), then there would be two different density requirements. In this case, the number of cores and the payment determination would be prorated by the quantity of mix. For example:

Lot 302 = 2000 tons total (5 roadway cores required)

1500 tons roadway
500 tons shoulder

2000 tons divided by 5 cores = 400 tons/core

1500 tons divided by 400 tons/core = 3.75, or 4 cores
500 tons divided by 400 tons/core = 1.25, or 1 core

Total cores must be 5.

Percent payment is as follows:

1500 tons @ 100 % payment

500 tons @ 95% payment

Each roadway report will reflect the percent payment for each portion The Certified Paving Inspector, along with the Contractor/Producer coring representative, shall inspect the cores for acceptability and label for them for identification. The DOTD inspector and QC technician, upon inspection and mutual agreement, also reserve the right to reject any core(s). It is intended that cores be delivered to the plant on the same day as they are taken, so that the results for acceptance and verification can be made available to the project engineer and field compaction personnel in a timely manner.

The original and one copy of the Asphaltic Concrete Pavement Report (Appendix AD) and the Asphaltic Concrete Verification Report (Appendix AE) shall accompany the cores to the plant for testing.

For HMA patching and widening, one sample will be taken per 200 tons (or less) up to a maximum of five samples for that portion of each lot placed on a project. If the portion of a lot that is delivered to a project extends beyond one day's production, a maximum of five samples will be tested for acceptance purposes. These five samples should be allocated so that they proportionally represent the percentage of the lot placed on the project each day. For density, sample and test the top four inches of finished sections.

Pavement density testing shall not be required for guardrail widening. In addition, pavement density requirements will not be applied to short irregular sections as per Subsection 501.12 of the Standard Specifications.

Consider the following example for core allotment:

- 875 tons of Lot 104 was placed on DOTD SP 123-45-1234 for widening.
- Day 1 = 375
- Day 2 = 170
- Day 3 = 175
- Day 4 = 155

Five samples would be used to represent the production placed for the four days on widening on SP 123-45-1234. Two samples would be selected to represent Day 1 and one sample would be selected to represent Day 2, 3 and 4 for Lot 104.

Subsection 503.02 of the *Standard Specifications* requires that a plant laboratory, in order to comply with certification requirements, be equipped with a saw suitable for sawing HMA pavement cores. This saw may be used by the contractor/producer to reduce patching/widening cores to four inches, remove base course material (i.e., soil cement or curing membrane), or to cut 4 or 6-inch diameter cylindrical samples. Care must be taken to minimize the amount of material cut and discarded, especially from the upper surface.

An example of determining percent payment for Pavement Density is as follows:

Lot 105= 1010 tons of Type 8 Wearing Course

Mix delivered to the following projects:

Project A = 506 tons
Project B = 463 tons
Project C = 41 tons

For Project A - 506 tons:

Core 1 -	92.1 % of G_{mm}
Core 2 -	92.0
Core 3 -	91.6
Core 4 -	91.3
Core 5 -	92.1
Average:	91.820 = 91.8 percent

The 506 tons from lot 105 delivered to Project A will be paid at 95 percent of the contract unit price (as per Table 501-5), based on the results of pavement density. The DOTD Certified Plant Inspector will notify the Certified Paving Inspector immediately so that action can be taken to correct the problem density. Results from other acceptance test could further reduce payment.

For Project B – 463 tons:

Core 1 -	92.6 % of G_{mm}
Core 2 -	91.5
Core 3 -	92.7
Core 4 -	93.1
Core 5 -	92.6
Average:	92.500 = 92.5 percent

The 463 tons from lot 105 delivered to Project B will be paid at 100 percent at the contract unit price, based on the results of pavement density. Results from other acceptance test could further reduce payment.

For Project C = 41 tons:

In this example, the project engineer only required one core, because the project is less than 250 tons.

Core 1 - 100.0 % of G_{mm}

The 41 tons for Lot 105 delivered to Project C will be paid at 100 percent of the contract unit price, based on the results of pavement density testing. Results from other acceptance tests could further reduce payment.

Note the following on the bulk specific gravity (G_{mb}) of a pavement core:

Weighing an object (as we do with an HMA core) to determine its weight in air and its weight in a fluid (as we do in water), whose specific gravity is known, yields sufficient data to determine its mass, volume, and specific gravity. Specific gravity is defined as the ratio of the weight of a unit volume of an object to the weight of an equal volume of water at approximately 23° C (73.4° F).

LA DOTD now specifies that the G_{mb} be determined by AASHTO T166, using the following equation to calculate G_{mb}:

$$G_{mb} = \frac{\text{Weight in Air}}{(\text{SSD Weight in Air} - \text{Weight in Water})}$$

The difference between the two methods is the replacement of the SSD Weight in lieu of the dry weight in air on the left side of the denominator. The reason for including this SSD weight is based on the fact that, when an HMA pavement core is submerged in water, the submerged weight increases as the external voids in the specimen fill with water. When this occurs, the volume of the displaced fluid (water) is decreased, which will increase the G_{mb} value. To account for this, we add the SSD weight to the left side of the denominator to cancel out the artificial increase in the G_{mb}.

However, as the size of the external voids in the specimen increases, it becomes difficult to determine an accurate SSD weight because the diameter of the voids are of such size that the water will run out of them before an accurate SSD mass can be determined.

Additionally, an absorptive aggregate (whose cross-sectional area is exposed on a cored pavement specimen) will absorb additional water which, in turn, will produce an artificially high G_{mb}.

To account for this absorption, AASHTO T 166 provides for an alternate test procedure (AASHTO T 275 – Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin) for determining G_{mb} *when the percent water absorbed by the specimen exceeds 2.0 percent when determined by the following equation:*

$$\text{Percent } H_2O \text{ Absorbed (by Volume)} = \frac{(\text{SSD Weight in Air} - \text{Weight in Air})}{(\text{SSD Weight in Air} - \text{Weight in Water})}$$

In addition to AASHTO T 166 and T 275, there are two other methods to determine G_{mb} *of a cored pavement specimen. One method, the Pure Volume method, is conducted by measuring the thickness and diameter of the cylindrical specimen in numerous locations to calculate average values and then using the following formula to determine its volume:*

$$\text{Volume} = \pi \text{ x} \left(\frac{\text{Diameter}}{2}\right)^2 \text{ x Height}$$

This volume is used in the denominator with dry weight in air and in the numerator, to determine the G_{mb}.

The second method, which uses proprietary equipment, involves weighing the submerged specimen in a vacuumed plastic bag to determine a "true volume."

In summary, if the QC technician or the DOTD inspector suspects that G_{mb} *values determined via AASHTO T 166 in the field laboratory are yielding erroneous values, they are to immediately consult with the district laboratory engineer for guidance.*

Surface Tolerance Requirements

The contractor/producer shall provide an approved 25-foot California-Type Ames Profilograph calibrated and operated in accordance with DOTD TR 641 for longitudinal surface tolerance quality control and quality acceptance testing. (The contractor may elect to use alternate or automated profilographs in lieu of the standard specified profilograph for quality control with the approval of the Materials Engineer Administrator.) For transverse and longitudinal surface tolerance acceptance testing the contractor shall also furnish a minimum 10-foot metal static straightedge.

Quality control test results have the same requirements as the acceptance test results. The quality control trace may be used for project acceptance, providing the DOTD inspector accompanies the profilograph operator and takes immediate possession of the trace upon completion of the quality control evaluation. Acceptance testing is required in both wheel paths.

The operation of the profilograph, including evaluation of the profile trace, determination of the Profile Index, calculation of the Average Profile Index and the determination of high points (bumps) in excess of specification limits shall be performed by a trained, authorized technician who has successfully completed the department's training and evaluation program for Profilograph Operator and/or Profilograph Evaluator.

Surface tolerance testing will be required on roadway travel lanes and airport wearing (one pass on either side of the runway centerline) and binder courses, and wearing courses on shoulders and in parking areas. For the purposes of surface tolerance requirements, the wearing course is defined as the last lift placed. The binder course is defined as the last lift placed prior to the wearing course. Other lifts on which additional HMA is to be placed shall be finished so that succeeding courses will meet the specification requirements.

The finished surface will be tested in the longitudinal direction for conformance to the surface tolerance requirements (listed in Table 501-5). When testing for roadway travel lanes and airport wearing and binder courses using the profilograph, one path in each paving strip in a lot will be selected for acceptance testing.

The contractor shall test the pavement during the first workday following placement, but in no case any later than 14 calendar days. (Profilograph operations should be scheduled to reduce traffic congestion around an on-going paving operation/train.)

When QC testing establishes that the surface tolerance is deficient, the contractor shall immediately suspend paving operations. Paving operations will not be allowed to resume until appropriate corrections have been made and a test section successfully placed with acceptable surface tolerance. This test section shall consist of a maximum of 500 tons of HMA placed in a continuous operation.

The contractor shall correct deficiencies identified during quality control testing. These deficiencies shall be corrected in the final wearing course by diamond grinding and applying a light tack coat, or removing and replacing, or furnishing and placing a supplemental layer of wearing course mixture at least 1 ½ inches of compacted thickness for the full width of the roadway at no direct pay. Deficiencies to be corrected in binder courses shall be corrected by diamond grinding or other suitable means to meet specification requirements.

After the contractor has completed QC testing and any required corrective work, the department will evaluate the profile trace from the contractor's quality control tests. Longitudinal variations in the final wearing course surface will be subject to provisions in Table 501-5 Payment Adjustment Schedules. The contractor will be allowed to evaluate the final quality control trace to determine if any corrective measures are needed to eliminate deficient areas. Upon completion of the contractor's evaluation, the DOTD inspector will take possession of the final QC trace to be used for project acceptance.

To correct deficiencies, it will be necessary to reprofile those affected areas and recompute the profilograph index using the original trace and the “reroll” traces. The department reserves the right to perform independent acceptance testing.

The surface of each shoulder will be tested longitudinally by the inspector at a minimum of one randomly selected location of each 300 linear feet of shoulder using the 10-fool metal static straightedge. The inspector will isolate areas with surface deviations in excess of ½ inch. The contractor shall correct these areas.

Excessive rippling of the mat surface will not be accepted. Ripples are small bumps in the pavement surface, which usually appear in groups in a frequent and regular manner. Specifically, a ripple is visible on the profile trace, but does not appear above or below the 0.2-inch (5 mm) blanking band required by DOTD TR 641. There shall be no more than 12 ripples or peaks in any 100-foot (30-m) section. Rippling indicates a problem with the paving operation or the mix that requires immediate correction by the contractor. Otherwise, the contractor shall cease operations. The contractor shall correct unacceptable areas at no direct pay.

In accordance with Subsection 501.12 of the *Standard Specifications,* surface tolerance requirements will not be applied to short irregular sections.

Transverse Surface Tolerance - The transverse surface finish shall be controlled so that the values shown in Table 501-3 are not exceeded.

Cross Slope Tolerance - When the plans require the section to be constructed to a specified cross slope, tests shall be performed at selected locations using a stringline, slope board or other comparable methods. The cross slope shall be controlled so that the values shown in Table 501-3 are not exceeded. Cross slope variation allowed in Table 501-3 shall be applied to each lane constructed.

Grade Tolerance - When the plans require the pavement to be constructed on a grade, tests for conformance shall be performed at selected locations using a stringline or other comparable method. Grade variations shall be controlled so that the tolerance shown in Table 501-3 is not exceeded. Grade tolerances shall apply to only one longitudinal line, such as the centerline or outside edge of pavement.

Surface Tolerance Variation	Transverse	Cross-Slope	Grade
Roadway Travel Lane Wearing Courses	1/8 inch	3/8 inch	½ inch
Binder Course	¼ inch	½ inch	½ inch
Shoulder Wearing Course	3/16 inch	¾ inch	¾ inch

Transverse and Cross Slope are based on 10 feet.
Grade is applicable only when specified.

The project engineer will review the profile trace obtained for each binder and wearing course on a per lot basis. In special cases or extenuating circumstances, the engineer may isolate sections of the profile trace out of specification. These “exception areas” are excluded from the calculations of the Average Profile Index. Specifically, neither the height of the scallop, nor the length of the exception area is used in the calculation. However, the percent payment for the lot does apply to the exception area. These special cases or extenuating circumstances may include curb and gutter sections which require the adjustment of cross-slope in order to maintain adequate drainage, manholes, catch basins, valve and junction boxes, street intersections or other structures located in the roadway which will cause abrupt deviations in the profile trace. The contractor shall correct high points in excess of 0.3 inches in 25 feet, unless in the opinion of the engineer, these high points do not cause damage to the roadway section or rideability. These high points then may be allowed to remain with a $500.00 per bump rebate. In all cases, the contractor has the option to grind the bumps to meet the specifications. The exclusion comments mentioned in this paragraph do not apply to multi-lift new construction and overlays with more than two lifts.

Dimensional Requirements (for mixtures specified on a cubic yard basis) – Over thickness and over width will be waived at no direct pay.

Under thickness shall not exceed ¼ inch when determined in accordance with TR 602. For the final wearing course, areas with under thickness in excess of the ¼ inch shall be corrected to plan thickness, at no direct pay. Corrective action should be made by furnishing and placing a supplemental layer of wearing course mixture, meeting specification requirements, over the entire area, for the full width of the roadway, when grade adjustments are permitted. When grade adjustments do not permit, the deficient area shall be removed and replaced at no direct pay.

Under widths, as determined in accordance with TR 602, shall be corrected by furnishing and placing additional mixture 1 foot wide and plan thickness at no direct pay.

DOTD DISTRICT LABORATORY – VERIFICATION RESPONSIBILITIES

The district laboratory performs verification testing to ensure that contractor and DOTD personnel in the field laboratories are using correct and accurate procedures, as well as proper equipment.

The district laboratory performs the following verification tests on HMA:

Sample	Tests	Frequency
Briquettes	Marshall Properties	2 per lot
Pavement Cores	Density	2 per lot
Loose Mix	Gradation	2 per lot*

*Two samples are delivered to the lab, but only the one that corresponds to an acceptance sample will be tested.

Verification samples must be delivered to the district laboratory in a timely manner so that the department and the QC technician may study the total quality control process and be assured that the results of sampling and testing used for acceptance and control are valid and representative of the material.

The results of verification testing for HMA materials shall be within the tolerances provided in the following table:

Test	Tolerance
Pavement Core	± 0.7 % of pavement density
Marshall Stability	± 600 pounds of plant test results
Flow	± 2 of plant test results
Density	± 0.3 lb/cu feet of plant test results
Gradation	No. 8: ±5%; No. 200: ±2%

If the results of verification tests are outside of these tolerances or the limits of the specifications, then the district laboratory engineer will notify the QC technician immediately. He will then send a written notice of the discrepancy to the project engineer. It will be the joint responsibility of the project engineer and the district laboratory engineer to investigate the problem and, if necessary, to inspect both the process and testing equipment, and the testing procedures in use at the plant.

The federally mandated Independent Assurance program requires that the district laboratory cut additional cores near the acceptance cores. It is necessary that station numbers appear on the project in accordance with Section 740, Construction Layout, and that the core holes are clearly identified on the pavement. For more information on Independent Assurance, see the *Materials Sampling Manual*.

In addition, as previously described, the district laboratory will perform verification analysis on asphalt cement and the Materials and Testing Section will perform acceptance testing.

EXAMPLE SUMMARY – APPLICATION OF PAYMENT ADJUSTMENTS

For the purposes of this example, assume that all test results and inspection procedures not covered by payment adjustments have met the requirements of applicable specifications.

Lot 105 = 1010 tons

Project A = 506 tons
Project B = 463 tons
Project C = 41 tons

Payment adjustments based on test for stability, gradation (No. 8 and No. 200 sieve sizes), percent anti-strip, and asphalt cement properties will apply to all 1010 tons of Lot 105.

Additionally, payment adjustments based on tests for pavement density and surface tolerance will apply to individual projects.

For Project A = 506 tons:	
Stability:	98%
Gradation:	98%
Anti-Strip:	99%
Asphalt Cement Properties:	100%
Pavement Density:	80%
Surface Tolerance:	80%

The 506 tons of Lot 105 of plant production delivered to Project A will be paid for at 80 percent of the contract unit price. Obviously, the roadway operation for this project is failing to satisfactorily meet the intent of the specifications for a quality uniform mixture; therefore, the operation should be terminated until satisfactory adjustments in laydown procedures have been implemented.

For Project B = 463 tons:

Stability:	98%
Gradation:	98%
Anti-Strip:	99%
Asphalt Cement Properties:	100%
Pavement Density:	100%
Surface Tolerance:	Not Applicable (Binder Course)

The 463 tons of Lot 105 of plant production delivered to Project B shall be paid for at 98 percent of the contract unit price.

For Project C = 41 tons:

Stability:	98%
Gradation:	98%
Anti-Strip:	99%
Asphalt Cement Properties:	100%
Pavement Density:	100%
Surface Tolerance:	Not Applicable (Patching)

The 41 tons of Lot 105 of plant production delivered to Project C will be paid at 98 percent of the contract unit price.

DEFINITION OF A LOT

Subsection 501.12 of the *Standard Specifications* defines a standard lot for normal HMA operations in terms of plant production. When a plant produces mixture for only one project, the lot size and the tonnage delivered to the project will be identical. But, when a plant produces the same mixture for multiple projects, portions of each lot will be allocated to each project. Under the latter circumstances, the term lot will refer to that portion of the standard lot delivered to each project.

A standard lot is 1000 tons of consecutive production of hot-mix asphalt from the same job mix formula produced for the department at an individual plant; however, minor adjustments will be made in the 1000-ton lot size to accommodate hauling unit capacity. When the total lot quantity is expended in the partial load of a truck, the full legal load of the truck will be included in the lot. For example, if 988 tons of HMA are produced and sent to a project and the next truck hauls 24 tons, the actual lot size will be 1012 tons (998 + 24).

All newly certified plants will begin production at standard lot size (1000 tons). However, when historical records indicate that an acceptable and uniform hot-mix is continuously being produced, **the standard lot size may be increased when agreed upon by the district laboratory engineer and the contractor/producer**. Once the expanded lot size has been established it must be adhered to on a continuous basis. Lot sizes should not be expanded beyond the plant's average, normal daily production rate. **It is not intended that lot sizes be frequently and arbitrarily increased or decreased to meet short-term production changes.** If the mixture, being produced during the expanded-size lot operations does not meet department criteria or shows evidence or non-uniformity, the district laboratory engineer reserves the right to unilaterally reduce the expanded lot back to the standard 1000-ton size. In addition, the expanded lot may be reduced to the standard 1000-ton size at any time by mutual agreement of the district laboratory engineer and the contractor/producer.

The lot number shall be indicated on each haul ticket. (The lot number may be either printed on the ticket via the printer system or written on the DOTD stamped form on the back of the ticket.)

The QC technician and DOTD inspector shall keep a running total of production to ensure that all lots are terminated at proper tonnage and that the succeeding lot number is placed on the next haul ticket. Lot numbers will be assigned based on total tons of plant production for a JMF. Lot numbers will be sequential to plant production for DOTD without regard to delivery points, individual projects, or mix types. Therefore, lot numbers for an individual project could start at lot number 001 or at any lot number thereafter and will not necessarily be sequential on a project.

The QC technician and DOTD inspector shall also maintain a written log of the distribution of hot-mix production for DOTD projects from a plant's operation. This log is to be kept in a numbered field book and shall contain, as a minimum, the following data:

Lot No.	Date	Project Number	Tons	Mix Type/Use	Project Engineer	Remarks	JMF	% AC/G_{mm}	Initials
023	14 Aug	123-44-5678	456.54	20/01	I. Schwartz	Tickets: 23-64	20.022	4.5% 2.503	C.V.J.
	15 Aug	123-44-5678	551.77	20/01	I. Schwartz	Tickets: 64-105	20.002	4.5% 2.505	C.V.J.
		Lot Total:	1008.31						
-----------Control Charts Are Up-To-Date ----------									

This log is to remain at the plant as a continuing record of plant production and distribution. It is to be maintained separately from all other departmental documentation. Notation shall also be made in the book to confirm that the Quality Control Charts are current. Lot numbers shall not be repeated until the plant has produced 999 lots.

The laboratory engineer or the QC technician may decide upon a smaller lot size based on any of the following conditions:

1. The total interval between continuous production exceeds 2 days. This may include, but not limited to, mechanical malfunction or inclement weather.

2. A new job mix formula is approved and used. When an approved JMF proposal is used the previous lot will be terminated at existing tonnage.

3. Final Lot. The quantity of HMA needed to complete the project is smaller than the lot size (i.e., the final lot is less than the lot size).

4. A payment adjustment will be applied to the portion of the lot already produced, provided plant adjustments have been made to bring the HMA into compliance with the specifications and the JMF.

In the event of a smaller lot size, the HMA shall be accepted on the average values of the tests performed. It is not the department's intent that this specification be used to artificially manipulate the size of lots that will be assessed payment adjustments.

The final lot on a project may be increased to within 150 percent of the stipulated plant lot size. For example, if a plant were operating with 2000 tons lots and the actual tonnage required to complete the project, following production for the second to last lot, is 2957 then the last lot for the project would have 2957 tons. However, in this case, if the actual tonnage required to complete the project is 3050 then two lots would be required; one with approximately 2000 tons and one with 1050 tons (adjusted for actual truck weights).

Application of a Lot Portion to Paving Operations – It is noted that the number of days required to produce a lot is not significant. A lot may cover more than one day's operation. The lot number shall be assigned based on plant production. When mixture from a single lot is being delivered to more than one project, the tonnage for each individual project will be less than total lot tons. The applicable lot number will be used for each portion of the lot delivered to the projects.

The DOTD Certified Paving Inspector will be responsible for coordinating the results of roadway tests (pavement density and surface tolerance) for each lot with the results of plant tests for that lot. The station limits per lane of each lot, as well as the total number of tons from each lot, must be documented in both the project field book and the Asphaltic Concrete Pavement Report (Appendix AD).

Tests run on material sampled at the plant will affect all projects receiving mix from the lot. Tests run on material sampled at the roadway will affect only the individual project. Pavement density (cores) and surface tolerance (on the final roadway or airport wearing course) will cause payment adjustments on the individual project. Gradation and Marshall stability tests, as well as asphalt cement acceptance and the incorporation of the JMF required percentage of anti-strip, will affect all projects receiving HMA from a lot. Payment adjustments, if necessary, per project, will be based on both plant and roadway tests. Therefore, the roadway must use the same lot number as the plant for the portion of a lot placed on that project. This procedure will normally result in non-sequential lot numbers at the roadway.

An example of applying HMA materials to specific lots, delivered to several projects, simultaneously, is as follows:

A plant is producing Type 8 Wearing Course HMA for three projects.

Lot 105	=	1010	tons
		506	tons to Project A
		436	tons to Project B
		41	tons to Project C
Lot 106	=	1020	tons
		710	tons to Project A
		310	tons to Project B
		0	tons to Project C
Lot 107	=	1008	tons
		406	tons to Project A
		292	tons to Project B
		310	tons to Project C

Accordingly,

Project A would show 506 tons matched to Lot 105, 710 tons to Lot 106 and 406 tons to Lot 107.

Project B would show 463 tons matched to Lot 105, 310 tons to Lot 106 and 292 tons to Lot 107.

Project C would show 41 tons matched to Lot 105, no tons to Lot 106 and 310 tons to Lot 107. Under no circumstances would Project C, in this example, use the Lot number designation 106.

This HMA mix distribution shall be documented, on a daily basis, in the Plant Log Field Book as previously described.

PROVISIONS FOR SMALL QUANTITIES

The department allows for some modification of sampling and testing frequencies and equipment inspection and certification for projects whose total plan quantity of HMA is less than 1000 tons. These modifications are also permitted when the plan quantity of HMA is less than 1000 tons at separate locations on the same project. The separate location is defined as an area that is constructed in a stand alone phase and when the plant is producing HMA mixtures for only that project.

250 to 1000 Tons of HMA – For projects, or separate locations within a project, requiring between 250 and 1000 tons of HMA, the QC technician shall take one sample for Marshall properties (stability, flow, V_a and VMA) for each 250 tons or portion thereof produced. Sampling and testing for aggregate gradation, asphalt content and percent crushed aggregate shall be determined twice [as per 501.12(b) and 501.12(c)(2)]. Percent anti-strip shall be determined once. Gradation, asphalt cement content, percent crushed aggregate, and percent anti-strip test results shall be documented on the QA copy of the Asphaltic Concrete Plant Report form (Appendix AB).

The QC technician shall take five samples for determination of pavement density, with the sampling distribution to be determined by the project engineer. Pavement density results shall be documented on the Asphaltic Concrete Pavement Report form (Appendix AD). Application of surface tolerance requirements will also be at the discretion of the project engineer.

No verification testing will be required. However, the inspector will sample asphalt cement and submit it to the district laboratory for acceptance.

The project engineer or the certified HMA paving inspector shall inspect all paving equipment to be used on the project to ensure that it meets the requirements of the specifications and is operating properly.

All HMA design requirements shall be in accordance with the requirements outlined in this manual.

The use of a material transfer vehicle (MTV) shall be at the discretion of the project engineer.

Less than 250 Tons of HMA – For projects or separate locations within a project requiring less than 250 tons, the JMF, materials, and plant and paving operations shall be satisfactory to the project engineer. One test for Marshall Properties (stability, flow, V_a and VMA) shall be required. Payment adjustments for Marshall stability shall be based on “Individual Test Within Lot” values shown in Table 501-5.

Percent anti-strip will be determined and noted on the QA copy of the Asphaltic Concrete Plant Report form (Appendix AB).

No verification testing will be required. However, asphalt cement for acceptance testing, will be sampled according to standard procedure.

The project engineer or the certified HMA paving inspector will inspect all paving equipment to be used on the project to ensure that it meets the requirements of the specifications and is operating properly. The equipment (asphalt distributor, spreader and rollers) does not require current certification stickers. However, equipment that does not produce a satisfactory mat will not be allowed to operate on any DOTD project.

All HMA design requirements shall be in accordance with the requirements outlined in this manual.

The use of a material transfer vehicle (MTV) will not be required for a project, or separate locations within a project, having a plan quantity less than 250 tons of HMA.

The project engineer reserves the right to waive any payment adjustments for small quantities less than 250 tons.

It is not the intent of the department that these modifications result in a product that does not conform to the requirements of the specifications. Therefore, all mixtures shall be produced at a certified plant. Materials shall be from approved sources and shall not exhibit any conditions or characteristics, which could be deleterious to the compacted mixture.

An approved job mix formula shall be developed and submitted on the Asphaltic Concrete Job Mix Release (Appendices T and U) to the project engineer in charge of the project for his approval.

JOB MIX FORMULA RESUBMITTALS

Should a contractor/producer submit a new JMF that is identical to a previously **approved** JMF except that a new source or type of asphalt cement is proposed (at the same proposed AC content), a new JMF is required. However, **only a new Asphaltic Concrete Job Mix Formula form, (Appendix W) along with moisture sensitivity analysis results (AASHTO T 283) (Appendix X), is required for this submittal**. Note that no validation results are shown on the submittal, requiring a new validation during production of the first lot produced from the approved JMF. Additionally, a new validation will also be required for T 283 during the first lot of production. This Lottman verification shall be conducted in the plant during the first lot of production. Results shall be reported the on TSR Form (Appendix V) and forwarded to the district laboratory engineer.

SUMMARY OF DOCUMENTATION

Asphaltic Concrete Plant Certification Report – The Asphaltic Concrete Plant Certification Report (Appendix A) is used to inspect the HMA plant for certification. In addition, a copy of the completed form is used for the 90-day inspections or intermediate inspections that are directed by the district laboratory engineer. An authorized representative of the district laboratory engineer completes two copies of this form. One copy is kept at the plant in the Plant Certification File. The other copy is forwarded to the district laboratory engineer.

Certification Report for Scales and Meters – This form will be provided by the department and can be obtained, along with all other DOTD plant documents, from the district laboratory engineer. This form is to be completed by the LA Department of Agriculture and Forestry or an authorized representative of an independent scale calibration company (hired by the contractor/producer) and submitted to the district laboratory engineer. This form, whether completed for initial plant certification or for subsequent 90-day checks, shall be prepared in duplicate. One copy shall be retained in the Plant Certification File at the plant; the other is to be forwarded to the district laboratory engineer.

Asphaltic Concrete Paving Equipment Certification – The Asphaltic Concrete Paving Equipment Certification forms (Appendices E, F, and G) are used by the district laboratory representatives to document the certification of asphalt distributors, pavers, and rollers. This form is designed to be used as a complete package to certify the entire paving train or in parts for the certification of individual pieces of equipment. Copies of equipment certification documentation will be supplied across district lines upon request to the certifying district laboratory engineer.

Asphaltic Concrete Paving Equipment Checklist – This form (Appendix I) is to be used by project personnel (Certified Paving Inspectors) at the beginning of each project to document that all paving equipment used on the project (except for projects with less than 1000 tons or for projects with less than 1000 tons on separate areas within the project) is certified and is operating in accordance with the standards under which certification was granted. Copies of these checklists shall be placed in the 2059 Review for the project on which the equipment was in operation.

This form is also to be used by the district laboratory representatives to document the ninety-day review inspections of certified equipment. It will be kept on file at the district laboratory with the original certification form and will be furnished to each project engineer within the district on a routine basis. Copies will also be made available across district lines upon request to the certifying district laboratory engineer.

Asphaltic Concrete Paving Miscellaneous Equipment Checklist – This form (Appendix I) is to be used as a checklist by the Certified Paving Inspector to be certain that all miscellaneous equipment is available on the project and is in acceptable condition. It will also be included in the 2059 Review.

Job Mix Proposal (Release Form) – In order to submit a job mix formula to the department for approval, the QC technician must complete the Asphaltic Concrete Job Mix Release form (Appendix X) along with other design data (Mix Design Worksheet, Optimum Asphalt Content Summary Sheet, Asphaltic Concrete Gradation Form, Lottman Test Results, and 0.45 Power Curve). An approved computer generated form may be used.

The QC technician shall enter the proposed mix design data on the JMF Release form and sign and date the form in the space labeled “Submitted for the Contractor by.” The form shall then be submitted to the district laboratory engineer for initial approval.

The district laboratory engineer will check all submitted information. If any information is incorrect, the district laboratory engineer will return the proposed JMF Release to the QC technician. If all information is correct and meets specifications, the district laboratory engineer will assign the sequence number, mark the form approved, sign and date it on the line labeled “Proposal Approved” and return the approved proposal to the QC technician. The plant will then be able to begin production for DOTD projects for validation purposes.

Prior to the **Validation Process**, as is the case prior to sending any HMA mixture to a DOTD project, the QC Technician shall forward a copy of the proposed JMF, either validated or invalidated, to the project engineer in charge of the project receiving HMA materials. A facsimile copy will suffice.

To validate the JMF proposal, the department will use the results of Marshall test properties, loose mix tests, asphalt cement content, and percent anti-strip from the meter or scales and compare them to the data recorded on the proposed JMF Release.

The department will perform validation testing on the first lot of plant production for the mix design. The QC technician’s test results for gradation, percent asphalt cement, and percent crushed, observed by the department’s certified inspector, will be used for validation and recorded on the JMF. A validation Lottman test (AASHTO T 283) will also be completed at the plant on the first lot’s production. When the validation process is complete, the district laboratory engineer will approve or disapprove the proposed JMF, sign and date the form, and distribute copies to the QC technician (for inclusion in the plant files) and the project engineer in charge of the project for which HMA materials are being supplied.

If the JMF is disapproved, the district laboratory engineer will mark the form Disapproved, enter the MATT laboratory submitter code, sign and date the form, then return it to the QC technician and the project engineer in charge of the project for which HMA materials are being supplied. If the district laboratory engineer disapproves the JMF Release, the QC technician must submit a new JMF Release proposal. No additional mixture can be produced for DOTD projects until the district laboratory engineer approves a new JMF Release proposal for validation.

If the JMF is approved, the district laboratory engineer then will mark the form approved, enter the MATT System Submitter Code, sign in the space labeled “Approved”, and date the form, then return it to the QC technician and the project engineer in charge of the project for which HMA materials is being supplied. If the district laboratory engineer approves the JMF Release, the plant can continue operations for DOTD projects having the same specification requirements as the mix design. The mix design will be approved for separate projects on an individual basis. Following validation, the JMF Release must be assigned to those projects, which receive mix produced from the JMF.

The district laboratory engineer will then distribute copies of the JMF Release to the project engineer, the QC technician, the Materials Engineer Administrator, and the Construction Audit Unit.

Once a JMF has been validated and approved, it may be used for other projects having the same specification requirements.

Asphaltic Concrete Gradation – 0.45 Power Curve(s) – The QC technician shall plot the proposed design gradation on the appropriate 0.45 Power Curve according the mixture's nominal maximum aggregate sizes. (Appendices T, U, and V.) This gradation plot must accompany the JMF Release when submitted to the district laboratory engineer for initial approval. A computer generated gradation plot may be used in lieu of the DOTD supplied form.

Mix Design Worksheet – The QC technician shall submit the Mix Design Worksheet (Appendix Q), along with the JMF Release form and supporting design data to the district laboratory engineer. A computer generated mix design worksheet may be used in lieu of the DOTD supplied form. This worksheet shall document, at a minimum, individual aggregate gradations used to create a composite blend, aggregate specific gravities (G_{sb}) and absorptions, trial blends with a minimum of three asphalt cement contents, along with G_{mm}, stability, flow, V_a, VMA and VFA calculated values.

Optimum Asphalt Cement Content – Summary of Test Properties – The QC technician shall submit the Summary of Test Properties form (Appendix U), along with the JMF Release form and supporting design data to the district laboratory engineer. An approved computer generated Summary of Test Properties may be used in lieu of the DOTD supplied form. Plots of V_a, VMA, VFA, Marshall stability, and flow shall be graphed versus percent asphalt cement as determined from the trial blends.

Tensile Strength Ratio (TSR) - The QC technician shall submit the Tensile Strength Ratio (TSR) form (Appendix W), along with the JMF Release form and supporting design data to the district laboratory engineer. An approved computer generated "TSR" form may be used in lieu of the DOTD supplied form. Careful attention should be made to the calculations required, via AASHTO T 283, for degree of saturation.

Asphaltic Concrete Plant Report – The Asphaltic Concrete Plant Report (Appendix AB) is a MATT System form. It is to be completed based on plant lot. Space has been allotted on the form for five individual projects, since the results of plant testing per lot will apply to each project receiving HMA mixtures from the lot. Therefore, it is imperative that each project to which mix is delivered be from a lot recorded on the form.

It is the joint responsibility of the DOTD certified plant inspector and the district laboratory to complete and sign this report. The QC technician is responsible for entering discharge temperature and moisture content. The DOTD inspector is responsible for entering “Header” information, Marshall test properties, JMF limits, metered quantities (percent asphalt cement and anti-strip), and percent pay. In addition to completing these parts of the form, the DOTD inspector is responsible for reviewing all entries for correctness and completeness.

The completed Plant Report is to be sent to the district laboratory with the Asphaltic Concrete Verification Report (Appendix AE), the loose mix sample for gradation acceptance testing and/or verification testing, and the two Marshall briquettes for verification testing. The Plant Report, when filed with the Asphaltic Concrete Pavement Report (Appendix AD), will complete documentation for acceptance of the HMA lot.

The QC technician shall use a separate copy of this form (stamped with one-inch high letters “QC” in red ink) to record quality control testing for extracted gradation, percent asphalt cement, and percent crushed aggregate. The QC gradation and percent asphalt cement, along with the QA result for maximum theoretical specific gravity of the paving mixture (G_{mm}), shall be plotted on the Asphaltic Concrete Control Charts.

An original and one copy of each plant report must be completed for acceptance. The signed original shall be sent to the district laboratory. The copy shall be kept in the plant files. The district laboratory engineer’s representative will review the information for completeness and accuracy and sign the form on the line labeled “District Laboratory.” The district laboratory engineer will then review the information and approve the form by signing in the line labeled “Approved By” before the information is entered into the MATT System. The MATT System will then generate a logging report for each project, one copy of which will be sent to the project engineer. The district laboratory will keep the original of the Plant Report. Copies will be sent to each project engineer receiving mixture from the lot.

Asphaltic Concrete Control Charts – The QC technician shall complete these charts as QC testing is completed. They are to be maintained on a lot basis. **Control Charts shall be plotted for extracted aggregate gradation, extracted percent asphalt cement, and maximum theoretical gravity of the HMA mixture (G_{mm}).** There is space for up to three entries per lot on each graph. Corrective action taken for deficiencies (or to bring the production process closer to median values) shall be documented, dated, and initialed on the back of the Control Chart by the QC technician. The Control Charts are to be kept at the plant. A copy of the Control Charts is sent to the district laboratory at the end of each project. A copy of the DOTD Control Chart form is shown in Appendix AC. An approved computer-generated form may be used in lieu of the DOTD supplied form.

Asphaltic Concrete Pavement Report – The Asphaltic Concrete Pavement Report form (Appendix AD) **will be completed for each mix use for each type mix for each project**. This will result in only one pay item being recorded on each form. The DOTD Certified roadway density data and corresponding percent pay information that is determined at the plant. The DOTD inspector will complete these sections. The DOTD certified paving inspector will sign and date the form in the space labeled "Roadway Inspector."

The Pavement Report, when filed in conjunction with the Asphaltic Concrete Plant Report, will complete documentation for acceptance of the pavement lot. An original, plus two copies, of this form must be generated. The DOTD certified paving inspector will keep one copy for project records. The original and one copy are to be sent to the DOTD inspector at the HMA plant with each set of pavement cores. The DOTD certified plant inspector will complete both copies of the form with pavement density information and percent pay, then sign and date the form on the line labeled "Plant Inspector." The original will then be sent to the district laboratory with the other completed copy retained for the plant files. A district laboratory engineer representative, upon receipt, will review the form for completeness and accuracy, initial and date it in the upper right corner, enter the information into the MATT System, and copy the form for use during verification testing. The original will then be sent to the project engineer receiving mixture for the lot for approval, signature, project records and 2059 submittal.

Any disposition of failing results or payment adjustments must be noted in the "Remarks Field" by the project engineer and returned to the district laboratory engineer for MATT System update. The district laboratory will then update the MATT System, copy the updated Asphaltic Concrete Pavement Report for laboratory files, and then return the original to the project engineer. The district laboratory will keep a copy of the updated report in the Disposition of Failing Test Reports file.

Asphaltic Concrete Verification Report – The district laboratory uses this form (Appendix AE) to report the results of Independent Assurance tests and verification tests on samples submitted by project personnel.

The DOTD inspector will complete an original and one copy of the Verification Report. The original will be attached to the Marshall briquettes, which are submitted to the district laboratory for verification testing. Before sending the form to the district laboratory with the briquettes, the inspector will enter the "Header" information and sample ID for the Marshall tests. All samples ID's will consist of the lot number plus sample number as identified by the plant inspector. The Verification Report and briquettes are to be sent to the district laboratory, along with Asphaltic Concrete Plant Report and the loose mix sample for verification.
The DOTD Certified Paving Inspector will complete an original and two copies of the Verification Report for each set of pavement samples sent to the plant for acceptance and testing. The original and one copy of the report must accompany the samples. The paving inspector will retain the second copy for project records. The paving inspector will complete the header information, Roadway Tests, and Sample ID.

After completing plant tests on the pavement samples, the certified plant inspector will forward the five samples to the district laboratory for verification testing. All sample ID's will consist of the lot number plus sample number. The inspector will then attach the original Verification Report to the original Pavement Report, which accompanies the pavement samples to the district laboratory.
The district laboratory will use these forms (Plant and Roadway information) to enter complete verification information into the MATT System. The MATT System will then generate a single logging report for the project engineer's records. If problems are

encountered during the verification process, copies of the Verification Report will be sent to the project engineer.

Ticket for Hot Mix Asphalt – Quantities (truck loads) of hot-mix asphalt materials delivered to DOTD projects shall be recorded on printer tickets, which are stamped on the back with the department stamp.

This stamped printer ticket is given to the driver of the certified haul truck. The driver, upon arriving at the paving site, will turn over this ticket to the DOTD paving inspector. The paving inspector is responsible for completing and signing the lower portion of the stamp.

Since lot numbers may not necessarily be sequential for a specific project, it is imperative that the number assigned to each ticket be sequential for each project for each mixture type. This number will include both lot number and sequential project ticket number.

As a minimum, the HMA ticket shall show the following information:

- Project Number
- Date
- Lot Number
- Ticket Number
- Truck Number (DOTD Certification Number for truck)
- Mix Type